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Should Producers of Hazardous Waste Be Legally Responsible for Injuries Caused by the Waste?

Intercollegiate Debate Topic
1983–1984

Pursuant to Public Law 88–246

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PUBLIC LAW 88-246, 88TH CONGRESS, S. 2311,

DECEMBER 30, 1963

AN ACT To provide for the preparation and printing of compilations of materials relating to annual national high school and college debate topics

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Librarian of Congress is authorized and directed to prepare compilations of pertinent excerpts, bibliographical references, and other appropriate materials relating to (1) the subject selected annually by the National University Extension Association as the national high school debate topic and (2) the subject selected annually by the American Speech Association as the national college debate topic. In preparing such compilations the Librarian shall include materials which in his judgment are representative of, and give equal emphasis to, the opposing points of view on the respective topics.

SEC. 2. The compilations on the high school debate topics shall be printed as Senate documents and the compilations on the college debate topics shall be printed as House documents, the cost of which shall be charged to the congressional allotment for printing and binding. Additional copies of such documents may be printed in such quantities and distributed in such manner as the Joint Committee on Printing directs.

Approved December 30, 1963.

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FOREWORD

This year marks the 20th anniversary of the passage of Public Law 88-246, which directed the Librarian of Congress to prepare bibliographies and collections of readings on the national high school and college debate topics. This year, as so often in the past, the Committee on Intercollegiate Debate and Discussion of the Speech Convention of America has selected a subject that is being debated in the Halls of Congress at the same time that students are wrestling with the issue. The debate topic for the 1983-1984 academic year is:

Resolved: That any and all injury resulting from the disposal of hazardous waste in the United States should be the legal responsibility of the producer of that waste.

The Congressional Research Service of the Library of Congress has prepared this compilation of readings and bibliographic references to assist collegiate debaters in researching this year's topic. The selections are intended to provide background information, an overview of the principal issues, and a balance of opposing views. We also attempted to include materials that are not readily available to the public, such as testimony from recent congressional hearings and excerpts from privately published papers. Bibliographic references were chosen to provide a wide range of information and opinions but were limited to materials that are generally accessible.

U.S. Government documents cited in the bibliography may be found in most U.S. Government depository libraries, a list of which appears in Chapter VI. The Library of Congress cannot distribute copies of these or other materials to the debaters.

A mini-research guide at the end of this volume contains descriptions of general research tools and lists of the search terms which can be used when using these tools. Finally, there is included a list of relevant publications that are available for purchase from the Superintendent of Documents, U.S. Government Printing Office.

The coordination and final selection of articles and citations in this document was the responsibility of Mark E. Anthony Reisch, Analyst in Environmental Policy, Environment and Natural Resources Policy Divison. Adrienne C. Grenfell compiled the bibliography, and Kristin M. Vajs prepared the mini-research guide; both are with our Library Services Division, Robert Meltz, Claudia Copeland, Michael Simpson, Meredith McCoy, David Whiteman, and Ms. Grenfell assisted in the literature review, and Leo Lesko obtained copyright releases of reprinted materials. Jan Mueller provided valuable production support.

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GILBERT GUDE,
Director, Congressional Research Service.

INTRODUCTION

A little over 5 years ago, on August 2, 1978, the New York State Health Commissioner declared a state of emergency to exist at the Love Canal neighborhood of Niagara Falls, and recommended that children under the age of two and pregnant women be evacuated. That event and the ensuing reports chronicling the fears and health problems of the residents dramatized the hazardous waste issue for the Nation in a way that dozens of previous pollution incidents had been unable to do. Two years and scores of dumpsites later the U.S. Congress passed what is now generally known as the Superfund law (the Comprehensive Environmental Response, Compensation, and Liability Act of 1980), which authorized the Federal Government to respond to chemical spills and dangerous disposal sites. That Act, however, had no provisions for compensating the victims for their medical expenses and other costs. Today the victim compensation (or toxic torts) issue is being argued by Representatives and Senators as well as by college debaters. It is an important topic. Thousands, perhaps tens of thousands, of people have a direct personal interest in how the question is defined and resolved. Billions of dollars ride on the outcome.

This volume offers information on a number of aspects of the issue: the nature of hazardous wastes and Federal law governing them, the difficulties victims face in receiving compensation, the threat of fraudulent, misdirected and exaggerated claims, proposals for change, and the possible impacts of those changes.

The first section in the handbook addresses the question of what hazardous wastes are and reviews technologies for their disposal. The opening selection, from John Quarles' book, provides examples of the processes generating the wastes and gives an overview of treatment methods. The piece also contains a cogent description of the nature of groundwater and the problems posed when it becomes contaminated. Since so many of the health problems caused (or alleged to have been caused) by hazardous wastes have resulted from their travel by groundwater, it is important to understand what we know—and do not know—about it. The second item is an issue of *Hazardous Materials Intelligence Report,* a weekly newsletter, providing additional information on disposal technologies. We have reprinted the other articles from that number which give an interesting snapshot of matters of concern in the summer of 1982: comments on the Environmental Protection Agency's (EPA) just-then released regulations on land disposal of hazardous wastes, and a review of the new rules of a State that has been a leader in this area: California.

Item 3 is an excerpt from a recent publication of the National Research Council, which is the principal operating agency of its better known parent, the National Academy of Sciences. Among other things, the Council concludes that there is no panacea to the hazardous waste disposal problem, but on the other hand, "Disregarding cost, there exists some technology or combination of technologies capable of dealing with every hazardous waste." Public attitudes and misconceptions also inhibit satisfactory management of wastes, according to the council. The next piece is an EPA "project summary," one of hundreds that the agency puts out to inform the interested public of the availability of recently published research reports. This one synopsizes a study of emerging disposal technologies, notes what wastes they would be suitable for, and comments on their benefits and drawbacks. The *Chicago Tribune* article, item 5, draws together the preceding themes through interviews with plant managers looking to dispose of hazardous wastes, and with executives of waste disposal firms. What comes through is that we are in a period of change in which the old ways of doing business are no longer acceptable, but one in which new patterns have not yet emerged.

Taking care of currently generated wastes is one problem; cleaning up the problems created by inadequate disposal practices in the past is another. Item 6, another EPA project summary, looks at the costs of a variety of cleanup technologies. An information gathering tool frequently used at land disposal sites is the monitoring well. At active landfills it can warn when a leak occurs, and at inactive, leaking sites it can help assess the nature and magnitude of a release. Item 7 discusses the reliability and limits of this technology. The next two excerpts are collections of data. Item 8 compiles the known health effects of a number of the chemicals most commonly found in contaminated groundwater, and item 9 contains a variety of statistics on hazardous wastes.

The second section of chapter I takes a look at the two principal Federal laws dealing with hazardous wastes: the Resource Conservation and Recovery Act of 1976 (RCRA); and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), frequently referred to as the Superfund law. Again, we start with an excerpt from the Quarles book in which he outlines the RCRA regulatory program governing the disposal of hazardous wastes, a regime that has been described by some observers as the most complex set of rules ever written by any Federal agency. Mr. Quarles served as general counsel and as deputy administrator of the Environmental Protection Agency from 1970 to 1977. RCRA is a prospective law and the regulations Congress directed EPA to promulgate are concerned with the safe handling and disposal of wastes at currently operating (and future) facilities. At the time of RCRA's passage in 1976, there was not the concern over—nor the knowledge of—the large number of sites that were threatening public health and the environment. The full scope of the problem is still not known, but when an idea of its breadth began to emerge, the congressional response was to pass CERCLA, a law authorizing the Federal Government to respond to those pollution incidents where other recourse was not available. Cleanup costs are paid for by the Superfund, seven-eighths of which is derived from a tax on the petroleum and chemical industries, and the remainder of which comes from the U.S. Treasury. These and other provisions of CERCLA are explained in items 2 and 3.

Passage of the Superfund Act did not result in the prompt cleanup of polluting hazardous waste dumps envisioned by some of the authors of the law. Congressional efforts to learn more about the program's implementation led to a constitutional confrontation between the executive and legislative branches when EPA Administrator Anne (Gorsuch) Burford was cited for contempt of Congress. Ultimately, she and some 20 other officials of the agency including the head of the hazardous waste programs, Rita Lavalle, either resigned or were fired. The events are outlined in item 4, and the next article considers what would be necessary "to rebuild a badly damaged program." The piece also provides insights into the practical workings of the EPA and the kinds of questions that arise in the process of turning a law passed by Congress into a functioning Federal program.

There are a number of difficult issues that must be faced when discussing the compensation of victims of hazardous wastes and none is thornier than proving causation of injury or disease. Chapter II looks at the reliability of scientific and medical evidence, starting with a note on the different requirements of scientific and legal proofs and an explanation of how animal experimentation and epidemiological studies are used by scientists. The second item considers the psychological effects manifested when people discover they are living on or near an old dump site. Among other things, the uncertainty and stress faced by the Love Canal residents led to a large number of separations and divorces. Item 3, "Just How Hazardous Are Dumps?," finds that "there is little agreement about how to assess the potential risks to health." One of the dangers is genetic defects, and items 4 and 5 explain what chromosome damage is and what it is thought to mean. The next article is a report on the experiences of the residents who live near the Stringfellow Acid Pits in California. Getting help often is not easy, and even when studies are done, there can be disagreement about what they mean. In July 1982, the U.S. EPA released a study that had taken 2 years and $10 million to complete to determine the habitability of the Love Canal area. Item 7 reports on a study of the EPA study performed by the Office of Technology Assessment (OTA), a congressional agency, in which OTA criticizes EPA's conclusions. Item 8 is a somewhat technical paper on the ability of medicine and toxicology to determine the causation of environmental diseases. The authors say that: "New ways of assessing the level of probability that an environmental or occupational agent and a disease are related must be utilized." In the next excerpt, item 9, the author argues that a fair standard of judgment in deciding whether exposure to a toxic substance caused a disease or injury is if the likelihood of his injury was doubled by his exposure; such a criterion would be "consistent with both science and law," and could "be reasonably adjudicated in the courtroom." Arguments over causation have been a feature of the environmental debate for well over a decade, and in item 10 the EPA Administrator during the Carter Administration gives his views on why environmental regulations cannot wait for scientific certainty. The last piece in this chapter presents the thoughts of a "science-policy thinker. . . . He discusses the major components of [hazard] assessment—characterizing risk, setting stable priorities, accommodating scientific and lay perceptions of risk, and weighing risks against costs and benefits."

In chapter III we turn to the victim compensation, or toxic torts, issue. The first two selections introduce concepts that the reader may find useful in the subsequent articles; both are from a recent National Science Foundation publication. The first reviews some aspects of tort law including such topics as theories of action (e.g., negligence, and strict liability), the forum in which a case is tried, the parties to a suit, and evidentiary requirements. The second describes the workings of three types of existing compensation systems: the social security disability program; worker's compensation; and collective liability systems such as the miners' black lung program, oil spill cleanup funds, and the Superfund program. Item 3 lays out precisely what the problems are that damage claimants face under the present system. Just getting into court is a major hurdle, and once there proving one's case is a difficult task. Item 4 tells of the Japanese response to the victim compensation problem, which may provide food for thought even though it concludes with a comment that their solution is probably not transferable to another culture. The next piece is testimony at a 1980 Senate hearing received from ten people who live near hazardous waste sites.

Articles 6 and 7 provide overviews of the debate in this country as of early 1983. Lois Ember's article also contains a convenient glossary of several legal terms. Item 8 presents the views of three authorities on toxic torts: an attorney with an insurance company, a law professor who served on a study commission authorized by the Superfund law (section 301(e)), and an attorney who specializes in representing individuals who have contracted occupational diseases and toxic chemical injuries. Lawyers also authored item 9, which reviews major problems with the current system, notes the goals for change, and considers the alternatives for meeting those goals.

While the Superfund law provides for response to hazardous substance spills and the cleanup of hazardous waste dumps it has no provisions for compensating personal injuries and property damages. However, section 301(e) of the law did call for a study of the adequacy of existing legal remedies. The study group's report appeared in September 1982 and has become the focus of much of the current congressional debate.[1] It recommended that another fund be established to compensate victims, and also that certain legal rules be changed to favor the victims. In item 10 the chairman and reporter of the section 301(e) study group summarize its findings and recommendations. The authors of the next two pieces were also members of the study group and in these excerpts from their testimony before a House of Representatives subcommittee they present their individual views on the report.

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[1] Injuries and damages from hazardous wastes—analysis and improvement of legal remedies; a report to Congress in compliance with section 301(e) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (P.L. 96-510) by the "Superfund Section 301(e) Study Group." Washington, U.S. Govt. Print. Off. [available from NTIS] 1982. 2 v.

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Part 1—The report and comments (PB-83-206052) and Part 2—Appendices (PB-83-206060).

At head of title: 97th Congress, 2d session. Committee print.

Several of the following items are also from that hearing before the House Subcommittee on Investigations and Oversight of the Committee on Public Works and Transportation in July 1983. One way that companies will try to protect themselves if liability legislation is passed is by taking out insurance. Items 13, 14, and 15 are testimony from the insurance industry in which the witnesses question the need for new legislation, express their concerns about changing legal principles of long standing, and speak of the problems that industry would face if they are saddled with costs that could run into billions of dollars per year. Item 16 is an excerpt from the statement of the representative of the Chemical Manufacturers Association in which he questions that there is a serious health problem from hazardous wastes.

The next two pieces are testimony favoring legislation based on the section 301(e) study group's recommendations. Item 17 is the statement of an attorney with the Environmental Defense Fund, and 18 is from the former Chief of the Hazardous Waste Section at the U.S. Department of Justice. One of the concerns of opponents is that there is no reliable way of predicting the costs of compensation programs. In 1979, a Carter Administration EPA official was asked to predict what the expense would be. His response is in item 19. The Reagan Administration has yet to formulate its position and officials from a dozen agencies are presently studying various aspects of the issue. An earlier review by the Office of Management and Budget (item 20) estimated "that seven percent of cancer deaths are related to exposures to pollution," and concluded "that to protect the public health, the Federal Government could make the most efficient use of the nation's resources by focusing new programs on decreasing the use of tobacco and encouraging improved dietary habits." Statements of EPA officials are items 21 and 22. The former, by the acting chief of research and development, focuses on EPA's risk assessment activities and certain scientific issues, and outlines the agency's current research efforts. The latter, by EPA's general counsel comments on current legislation before the Congress and touches on several other issues, including the potential impact of victim compensation on other EPA programs.

An alternative model law was developed by the Environmental Law Institute and is summarized in item 23. It is broader than the section 301(e) proposal both in the victims it would recompense, and the industries it would tax. Item 24 presents the labor union point of view as expressed by two officials of the AFL-CIO. Their proposal is designed to compensate workers who contract occupationally attributable diseases, and would establish trust funds for each industrial category. The next item provides an interesting note: of 24,000 asbestos related lawsuits reviewed, the victims and their families received only 37 percent of the $1 billion spent by both plaintiffs and corporate defendants. Item 25 asks: "Are superfunds and tort law reforms insurable?" and the author answers with "a cautious and qualified yes." The article provides an interesting comparison with the Price-Anderson Act and two European conventions that provide insurance regimes dealing with the production and use of atomic energy.

The selections presented are a sampling of the different opinions that are emerging in the victim compensation/toxic torts debate.

Their inclusion here does not imply that they are the only viewpoints on the subject. Indeed, at this writing, the Reagan Administration and large sectors of the business and industrial community have yet to make their voices heard. We can also expect to hear additional ideas from academia, the various private "think tanks," and journals of opinion. With one or two possible exceptions current news items are not presented; these are generally familiar and easily accessible through basic research.

The bibliography (following the text materials) is organized along lines similar to the text selections. The items listed should present the debater with other facts and issues to consider, as well as several additional points of view. There is also a section outlining major sources which might be pursued for additional materials and a list of Federal Government publications which may be purchased.

Text items and bibliographic citations have been selected with a concern for presenting numerous points of view. While rough, overall balance among several selections has been an important goal, individual selections may be highly skewed towards a particular point of view. Each individual author is, of course, responsible for the views and analysis presented therein, while each debater will want to make his or her own assessment of the validity of the arguments raised.

CHAPTER I

BACKGROUND

A. HAZARDOUS WASTE PRIMER

THE COMPLEXITIES OF HAZARDOUS WASTE AND GROUNDWATER

Summary

- The term "hazardous waste" embraces a broad array of waste materials that differ markedly from each other.
- Hazardous wastes are generated by almost all industrial activities, including:
  - manufacturing processes
  - end-use activities
  - finished products that have become unusable or unwanted
  - spills during transportation
- Regulation of the vast numbers of hazardous wastes is further complicated by the many different methods and facilities by which they may be handled, including:
  - storage for varying periods of time
  - various forms of treatment—physical, chemical, biological, and thermal
  - disposal in landfills, surface impoundments, landfarms, deep-well injection, and resource recovery
- Knowledge concerning contamination of groundwater is extremely limited. The dynamics of groundwater migration are not well understood. Reliable data is nearly nonexistent.
- Current remedial technology has several drawbacks, including serious questions about reliability and effectiveness.

*Reproduced with the permission of the copyright holder from John Quarles, Federal Regulation of Hazardous Wastes: A Guide to RCRA. Washington, Environmental Law Institute, 1982. p. 13-35.

Background

Hazardous waste excites strong emotions and impassioned rhetoric. Incidents such as those at Love Canal in New York, where some 82 identified toxic chemicals, 11 of them suspected carcinogens, began to migrate from a closed chemical dump,[1] and the "Valley of the Drums" in Kentucky, in which some 30,000 unlabeled drums of chemical waste were found,[2] have brought the problems associated with hazardous waste disposal dramatic nationwide publicity.[3]

Strong language from public figures has heightened the concern. Congressman Albert Gore remarked, for example, "America has been pockmarked with thousands of cancer cesspools,"[4] and a former United States Assistant Attorney General stated:

> We do not know where the millions of tons of stuff is going. We feel that the things that have turned up like the Love Canal and Kin-Buc situation are simply the tip of the iceberg. We do not have the capacity at this time really to find out what is actually happening. In my view it is simply a wide-open situation, like the Wild West in the 1870s, for toxic waste disposal.
>
> The public is basically unprotected. There just are not any lawmen out there, State or Federal, policing this subject.[5]

These incidents directed attention to a new concern: the danger of contamination to groundwater. This part of our environment had been largely neglected in earlier efforts to control pollution. Widespread use of groundwater for both public and private drinking water supply raised quick anxieties, however, once a threat of contamination appeared. These concerns doubtless were intensified by the fact that there is little common understanding about the nature and use of groundwater.

In sheer size alone the hazardous waste management challenge is awesome. EPA estimated in 1980 that about 10 percent by weight of all industrial waste would be covered by the RCRA definition of hazardous waste[6] and that as many as 750,000 businesses generate such waste.[7] Based upon studies of selected manufacturing industries conducted between 1975 and 1978, EPA estimated that the annual volume of hazardous wastes generated by these industries was approximately 47.5 million metric tons.[8] EPA projected that between the years 1974 and 1983, hazardous waste generation would increase at an annual rate of 3.6 percent per year,[9] (although the advent of regulation may change that pattern of growth). Moreover, EPA's conclusion, based on its 1975 studies, was that approximately 90 percent of hazardous wastes were "managed by practices which were not adequate for protection of human health and the environment."[10]

Anxious public concern. Shouts of political outrage. The seemingly pervasive presence of hazardous wastes across the American countryside.

These were the forces that compelled the enactment of RCRA, with tight deadlines to erect a comprehensive regulatory framework.

The complexity of the challenge of regulating hazardous wastes was neither hidden nor distorted. It simply was not recognized. Yet that complexity is the single most important factor in the foundation upon which the regulatory framework must be built. The best place to start is to look at the types of wastes covered by that simple label, "hazardous waste."

The Universe of Hazardous Wastes

The statutory language of *RCRA explicitly defines hazardous waste to encompass essentially any waste that may pose a substantial hazard to either human health or the environment "when improperly . . . managed."*[11] This is the cornerstone for the regulatory structure. Problems with wastes posing hazards have arisen because those wastes have not been properly managed. Poor management had been documented in repeated situations. It was (and is) logical, therefore, to acknowledge a direct linkage between the jurisdictional coverage set by a definition of hazardous waste and an assumption of poor management.

Despite that logic, the *implications of basing the definition of hazardous waste upon the assumption of improper management* warrant thoughtful reflection. Because an endless range of materials have at least some potential to cause harm assuming they are mishandled, that assumption *leads inevitably to an expansive jurisdictional coverage*. As EPA has developed its regulations, the term has indeed embraced *a broad array of waste materials that differ markedly from each other in their hazard-producing potential.* That remains true even after a number of special exclusions have been made, either by Congress or by EPA, to remove from the regulatory program various categories of waste materials such as domestic sewage, household wastes, irrigation return flows, industrial wastewater discharges regulated under the Clean Water Act, nuclear material regulated by the Atomic Energy Act, certain agricultural wastes, and most wastes generated by mining operations, electric power generation facilities, and oil and gas exploration and production operations.[12]

On even a quick review, these contrasts are readily apparent. Hazardous wastes range from those that may threaten severe health or environmental impacts when present even in small quantities or low concentrations to other wastes which do not present any significant threat unless released to the environment in large volumes of heavy concentrations. In addition, the type of threat posed by different classes of wastes is also open to wide variation.

Some wastes are hazardous because they may explode or ignite under certain conditions, (although under other conditions they may degrade quickly and harmlessly). Other wastes may be extremely acidic or alkaline, presenting a high risk of corroding their containers and then causing environmental harm. Still other wastes may contain persistent chemical compounds that could threaten adverse health effects if human beings should be exposed to them.

These differences in the physical qualities of various wastes led to EPA's identification of four basic characteristics, any one of which may cause a waste to be classified as hazardous—ignitability, corrosivity, reactivity, and toxicity. The differing threats posed by wastes with these distinct characteristics obviously present differing management needs and control requirements. Since these differences in both the intensity and nature of hazardous quality severely complicate the task of establishing a regulatory framework, they should be kept clearly in focus in taking a quick look at the principal types of situations in which hazardous wastes may be found.

Wastes are generated by almost all activities. EPA has stated that 150 million tons of municipal solid waste are generated annually, another 240 million tons of industrial waste (dry weight) are yearly disposed of in land facilities, and some 10 trillion gallons of liquid wastes are placed in pits, ponds, and lagoons every year.[13] The activities generating hazardous waste may be grouped into four broad categories: *manufacturing processes; end use activities; finished products that have become unusable, unneeded or unwanted*; and *spills during transportation of hazardous nonwaste materials.*[14] A brief comment on each of these categories will help to fill in the general picture.

Manufacturing Processes

Manufacturing processes are the most obvious source of hazardous wastes. They produce such wastes in large quantity and wide variety. A glance at Table 1 will provide a quick illustration of the generation of hazardous wastes within various industries, indicating the quantities of hazardous wastes generated in 1975 by 19 industry groups in the 2-digit SIC codes 20 and 22 through 39.

As the table indicates, industries in five of the SIC code groups accounted for nearly 88 percent of the 47.5 million tons of hazardous waste generated during 1975. Clearly the most important group was *chemicals and allied products*, which accounted for approximately 60 percent of these wastes. That was followed by *machinery* (except electrical) (ten percent), *primary metals* industries (eight percent), *paper* and allied products (six percent), and *fabricated metal products* (four percent).

It is also revealing to consider the diversity of specific wastes likely to be generated by individual manufacturing facilities. Although no single operation is apt to generate all of the potentially hazardous wastes indicated, Table 2 suggests representative types of wastes generated by manufacturing processes in several different industries.

End-Use Activities

A second category of activities which generate significant quantities of hazardous wastes includes operations involving a finished product such as

Table 1[16]

HAZARDOUS WASTE GENERATION IN 1975

Standard Industrial Classification	Total*	Percent of Total	Ranking
20-Food and kindred products	290	0.5	10
22-Textile mill products	140	0.5	15
23-Apparel and other textile products	130	0.5	16
24-Lumber and wood products	80	<0.5	18
25-Furniture and fixtures	240	0.5	12
26-Paper and allied products	2,870	6	4
27-Printing and publishing	130	0.5	17
28-Chemicals and allied products	28,700	60	1
29-Petroleum and coal products	950	2	7
30-Rubber and miscellaneous plastic products	220	0.5	13
31-Leather and leather products	640	1.5	9
32-Stone, clay, and glass products	1,390	3	6
33-Primary metal industries	3,830	8	3
34-Fabricated metal products	1,800	4	5
35-Machinery, except electrical	4,650	10	2
36-Electric and electronic equipment	200	0.5	14
37-Transportation equipment	940	2	8
38-Instruments and related products	65	<0.5	19
39-Miscellaneous manufacturing industries	270	0.5	11
TOTAL	47,500		

*(1,000 metric tons per year)

NOTE: Totals may not equal 100 due to rounding.

building construction or agriculture. Such activities generate four broad categories of potentially hazardous waste:

1) Used containers holding residual product;
2) Spills of potentially hazardous products;
3) Broken, discarded, or nonfunctioning products; and
4) Residuals from product consumption.[17]

An example of wastes in the first category would be empty pesticide containers. Once the pesticides, which are themselves potentially hazardous, have been applied, the containers holding some residue of the product are discarded and thus become a potentially hazardous waste. EPA data indicate that in 1971 some 98 million empty pesticide containers, with an estimated weight of 20,000 metric tons, were discarded by 2.5 million farmers.[18]

If spilled, certain materials and the residue from their cleanup will become hazardous waste. For example, if a listed pesticide were spilled during formulation, the spilled product mixed with the contaminated cleanup materials would be treated as hazardous waste.

Potentially hazardous wastes in the third category, products that are broken or have outlived their useful lives, include spent solvents and automotive oils, used drycleaning fluid, PCB-containing electrical equipment, and waste

Table 2[18]
EXAMPLES OF POTENTIALLY HAZARDOUS WASTES FROM THREE SELECTED INDUSTRIES

Manufacturing Industry (SIC Code)	Potentially Hazardous Waste Stream	Potentially Hazardous Wastes
Textile Mill Products (22)	Wastewater Treatment Sludge	*Heavy metals* (e.g. arsenic, barium, cadmium); *Dyestuffs* (containing heavy metals, dyecarriers, e.g. biphenyl, trichlorobenzene); *Residual organics* (e.g. chlorinated organics).
	Dye and Chemical Containers	*Residual dyestuffs and chemicals* (e.g. dichromate salts, organic phosphorus compounds).
	Solvent Wastes and Still Bottoms	Acetone, methanol, trichloroethane, naphtha.
Inorganic Chemicals Industry (281)	Wastewater Treatment Sludges and Slurries	*Heavy metals* (e.g. mercury); cyanide, chromium.
	Other Solids	*Heavy metals*, arsenic, uranium compounds, fluorides.
Electronic Components Manufacturing (367)	Solvents	*Halogenated solvents* (e.g. trichloroethylene); *Non-halogenated solvents* (e.g. acetone, methanol, xylene).
	Wastewater Treatment Sludge	*Particulates* (e.g. metal oxides); *Metal ions* (e.g. lead, zinc); *Fluorides* (e.g. silico-fluorides).
	Waste Oils	*Hydraulic and lubricating oils* (e.g. petroleum distillates contaminated with heavy metals and additives).
	Paint Wastes	Pigments, oils, plasticizers, fungicides.
	Metal Scrap	Heavy metals (e.g. beryllium oxide).

construction material containing asbestos.[19] The fourth category of potentially hazardous wastes generated by end-use activities, residuals from product consumption, would include ash and emission control sludges left over from the combustion of coal or other materials containing hazardous substances to produce energy.[20]

Unusable, Unneeded, and Unwanted Products

This third broad category of hazardous waste generation is largely self-defining. Products may become obsolete or unacceptable for a number of reasons, such as deterioration, decomposition, or governmental action. In this group of wastes are such substances as recalled or overage drugs, pesticides like DDT or chlordane that have had their federal registration cancelled, and obsolete military munitions, *e.g.*, explosives and gases.[21]

Transportation-Related Spills of Non-Waste Materials

Both the spilled product and the contaminated soil, water, and cleanup materials are potentially hazardous wastes. The major sources of spills in this category are from barge, train, truck, and pipeline related transfer and transport.[22] The types of potentially hazardous materials that have been spilled in the past vary widely, ranging from assorted acids to seed corn treated with captan.[23] Hazardous materials transportation spills occur frequently. Between January, 1971, and December, 1975, the Materials Transportation Bureau of the U.S. Department of Transportation received some 32,000 hazardous materials incident reports.[24]

Diversity of Management Practices

The diversity of substances which may be classified as hazardous waste has already been suggested. *The full complexity of regulating hazardous waste can be appreciated, however, only as one begins to multiply that diversity of waste materials in the context of the many different situations in which they may occur and the many different methods by which they may be handled.* The regulators' challenge is of course to prescribe appropriate controls for each type of waste in each type of situation to prevent environmental damage, within the bounds of technological feasibility and acceptable cost. The following discussion will highlight the most common practices for storing, treating, and disposing of hazardous waste.

The handling of hazardous wastes occurs both "on-site" at the location where the wastes are generated and "off-site" at municipal and private landfills, incinerators, resource recovery plants, and other hazardous waste management facilities.[25] *Most industrial wastes are handled on-site.* Of the hazardous wastes generated by the manufacturing industries studied, EPA found that some 82 percent of the wastes were treated or disposed of on-site, about 15 percent taken off-site, and about three to five percent subjected to resource recovery practices.[26]

Storage

Most hazardous wastes are stored at least temporarily before treatment or disposal. If wastes are shipped off-site, they may be accumulated for months or even years until it is economical to ship them.[27] Depending on their volume and nature, *wastes are stored in a variety of containers or facilities.* A standard piece of storage equipment is *the 55-gallon drum.* As drums accumulate, they present the question of where the drums should be stored. Larger quantities of liquid wastes often are stored in *metal tanks*, or in huge *lagoons*. Solid matter often is stored in *waste piles*. In some cases, when there is no known safe method of treating or disposing of certain wastes, they have been subjected to *engineered storage* and held for long periods of time.[28] Such wastes have included arsenic trioxide, kepone, chemical warfare agents, and phosphorous and mercury-containing wastes from inorganic chemical industries.[29] The nature of the hazardous waste, and also its quantity, will affect what environmental safeguards are needed to assure secure storage, in addition to whether such storage is expected to last for days or for decades.

Table 3[30]
TYPICAL STORAGE PRACTICES

Industry	Waste	How Stored	Storage Time
Pesticides	Empty insecticide containers	Bin	3 months
Pharmaceuticals	Radioactive material	Drums with vermiculate	3–4 months
Paints and Coatings	Emulsion sludge from tank washings	Holding tank	1–2 days
Metal Finishing	Sludges; metal precipitate	Holding tank	years

Treatment

Industry employs many different processes to treat hazardous wastes. In some cases the purpose of treatment is to eliminate the hazardous waste. In others cases, treatment merely reduces the volume of hazardous materials (e.g. dewatering) or separates hazardous constituents from other waste matter.[31] In many instances, such as wastewater treatment, more than one method of treatment may be employed, and commonly such treatment yields some other material such as sludge that may itself be hazardous and require special disposal.

The various types of treatment may be generally classified in four basic categories. These are (1) physical treatment, (2) chemical treatment, (3)

Table 4[32]
PHYSICAL TREATMENT METHODS

Process	Treatment Agent(s)	Wastes Treated
Carbon Adsorption	Solid Carbon	Organic wastes, heavy metals, other inorganics
Stripping	Steam, inert gas	H_2S, NH_3, phenols, volatile organics
Filtration	Screens, cloths, particulates	Sludge dewaterings, removal of suspended solids
Gravity Separation [Sedimentation, Flotation]	Chemical conditioners	Oils, air entrapped particulates, suspended materials
Flocculation	Alum, ferric chloride	Very small suspended particles
Evaporation	[Ponds lagoons, aerators, sprayers]	Evaporation of wastewater

biological treatment, and (4) thermal treatment. *Physical treatment*, such as passing a wastewater stream through a mechanical filter, involves a nonchemical process for removal or concentration of soluble and/or suspended components of the waste stream.

Chemical treatment involves a process through which the molecular structure of hazardous wastes is changed, usually by reaction to chemicals that are added to the waste matter, to make them less hazardous.

Table 5[35]
CHEMICAL TREATMENT METHODS

Process	Treatment Agent(s)	Wastes Treated
Neutralization	Sulfuric acid, soda ash, lime slurries, boiler-flue gas	Acids, caustics, wastewater treatment
Precipitation	Lime, sodium hydroxide, sulfides	Heavy metals, other soluble chemicals
Oxidation	Oxygen, chlorine, ozone, peroxide	Organic or inorganic wastes containing strong reducing agents, e.g., cyanide-containing wastes
Reduction	Sulfur dioxide, sulfite salts	Organic or inorganic wastes containing a strong oxidizing agent, e.g., hexavalent chromium
Ion exchange	Packed bed of resin	Wastewater, e.g., used to remove chromic acid
Chemical fixation	Inorganic chemicals and catalysts	Sludges

Biological treatment relies on the use of microorganisms to treat organic materials, causing such materials to decompose through metabolism or adsorption by the microorganisms. Since the bacteria or other micro-

Table 6[35]
METHODS OF BIOLOGICAL TREATMENT

Process	Treatment Agent(s)	Wastes Treated
Trickling filters	Packed bed (stones or synthetic) covered by microbial film	Acetaldehyde, benzene, chlorinated hydrocarbons, nylon, rocket fuel
Activated sludge	Aerobic microorganisms suspended in waste-water	Refinery, petrochemical and biodegradable organic wastewaters
Aerated lagoon	Surface impoundment plus mechanical aeration	Biodegradable organic chemicals
Waste stabilization ponds	Shallow surface impoundments plus aeration to promote growth of algae and bacterial and algal symbiosis	Biodegradable organic chemicals

organisms may be sensitive to, or even destroyed by, other substances in a waste stream, it may be necessary to employ some preliminary processes of treatment to eliminate toxicity before biological treatment.[34]

Thermal treatment, or incineration, destroys or renders wastes less hazardous through the application of heat. It can be used to recover energy and materials from the wastes, especially wastes such as petroleum derivatives which have a high combustion value.

Table 7[36]
METHODS OF THERMAL TREATMENT

Process	Description	Wastes Treated
Open burning	Combustion without control of air, containment of reaction, and control of gaseous emissions.	Waste explosives.
Open pit burning	Combustion in a screened pit equipped with air injection nozzles.	Industrial trash, tar sludges.
Incineration	Enclosed device using controlled flame combustion.	
(a) Rotary kiln	Rotating combustion chamber temperatures from 810°C to 1650°C.	Combustible solids, liquids, gases, tars, sludges, waste chemical warfare agents, and munitions.
(b) Fluidized bed	Bed of inert granular material, e.g., sand. Air forced up through bed to make particles act like a fluid. This agitation causes mixture of waste with air and allows larger particles to be burned. Temperatures generally from 760°C to 870°C.	Petroleum and paper industries, sewage sludge.
(c) Multiple hearth	Refractory lined shell with hearths located above one another. Wastes injected at top and fall from one hearth to another. Temperatures from 315°C to 980°C.	Sewage sludge, tars, solids, gases.
(d) Liquid injection	Vertical or horizontal units into which atomized waste is sprayed. Temperatures from 650°C to 1650°C.	Combustible liquid wastes, e.g., chlorinated hydrocarbons.
High temperature processing	Heat and/or pressure used to destroy or alter waste.	
(a) Calcination	Thermal decomposition used to drive off volatiles and leave a dry powder.	Carbonates, hydroxides, sulfites, sulfides.
(b) Wet oxidation	Solids solubilized and oxidized under high pressure.	Sewage sludge.
(c) Pyrolysis	Destructive distillation in absence of oxygen. Wastes broken down into solid, liquid, and gaseous components.	

As explained below, incineration is technically classified as a method of treatment, not disposal, but it plays a major role in the disposal of industrial wastes. As environmental concerns over groundwater protection lead to tightening regulatory controls over on-land disposal practices, increasing the cost and perhaps also reducing the availability of such methods for disposal, it is likely that industry will turn to incineration with increasing frequency. The environmental considerations affecting incineration are of course totally distinct from those affecting land disposal, and careful analysis will be required to determine the circumstances in which the various alternative methods are most suitable from an overall viewpoint.

Disposal

The lines between storage, treatment and disposal are somewhat arbitrary and may sometimes lead to confusion. Some processes straddle two or more of those categories. Incineration, for example, may be classified as thermal treatment insofar as it produces a residual material (ash) that must itself be disposed of, but at the same time since the process destroys the bulk of waste matter subjected to combustion it operates in practical effect as a method of disposal.

For regulatory purposes, RCRA's statutory definition of disposal covers any facility which would permit substances to be released into the surrounding environment. This would cover some units that are generally regarded as serving the purpose of storage. In general usage, however, a disposal facility is one where waste materials are placed or abandoned by man with no intent of further movement or handling. The principal environmental concern over hazardous wastes is that after such materials have been disposed of they may not stay put but instead may move through the environment in unknown, unintended and undesired directions. Disposal facilities are the chief targets of that concern.

A 1979 study conducted for EPA produced a "ballpark estimate" that nationwide some 32,000 to 50,000 sites (including a large number of municipal landfills) *may* contain hazardous wastes.[37] There appear to be somewhat under 2000 active hazardous waste disposal facilities.

EPA also made studies of the disposal practices of 14 manufacturing industries between 1973 and 1975 which provide a breakdown of hazardous waste disposal practices. That breakdown is shown in Table 8. It reveals the striking fact that, within those industries, nearly half of the hazardous waste materials were disposed of in surface impoundments, and that all but a small fraction of hazardous wastes were disposed of by just three methods: surface impoundments, landfills (or dumps), and incineration.

Surface impoundments are natural depressions, manmade excavations, or diked-in areas, made primarily of earthen materials, that are used to contain liquids or wastes containing free liquids.[39] They may be lined or unlined. Types of hazardous waste surface impoundments include pits, ponds, and lagoons used for hazardous waste storage, holding, settling, aeration and disposal.

Table 8[39]
DISPOSAL PRACTICES OF 14
MANUFACTURING INDUSTRIES

Disposal Method	Percent of Waste Disposed by Method
Surface impoundment	48
Landfill dump	33
Incineration	15
Deep-well injection	2
Land treatment	0.3
Road application	<0.1
Sewer	<0.1
Other (chiefly resource recovery at disposal site)	2

Physical, chemical, and biological treatment processes, such as evaporation, biochemical stabilization, and neutralization are carried out in surface impoundments.[40]

EPA estimates that there may be as many as 176,000 surface impoundments in the United States, although many of these are agricultural and mining impoundments and only a small fraction of all impoundments are likely to contain hazardous waste.[41] In one study, EPA acknowledged that it did not have the data to estimate the total amount of hazardous wastes put into surface impoundments, nor the percentage of those wastes ultimately disposed of in impoundments.[42] Another EPA study, however, suggested that *industrial* surface impoundments contained about 33 percent potentially hazardous constituents, and that more than 68 percent of the surface impoundments in the chemical and allied products class contained potentially hazardous materials.[43]

The most serious threat to human health and the environment posed by surface impoundments is leakage to groundwater. Air emissions of volatile materials, and overtopping caused by overfilling, precipitation, or wind may also present problems.[44] To mitigate these potential threats, EPA is requiring new surface impoundment facilities (and new landfills) to be equipped with either liners and groundwater monitoring systems or double liners and leachate detection systems.[45]

Landfills are disposal facilities in which hazardous wastes are placed directly in or on the ground.[46] Management of hazardous wastes through land filling (and open dumping)[47] ranked second to surface impoundments in the amount of hazardous wastes received, according to EPA studies (see Table 8 above).

In reviewing historical development of the landfills currently in existence, these facilities can be grouped into three categories, which for convenience of description may be referred to as follows: general purpose, sanitary, and secured. *General purpose* landfills are those facilities with no special containment, monitoring, or leachate collection systems that have been placed with no particular regard to the potential effect of the facility on water resources. EPA's studies led the Agency to find that most industrial hazardous wastes disposed of in landfills have been received by facilities of this type.[48] In contrast to open dumps, however, general purpose landfills do periodically cover the wastes.[49]

Sanitary landfills (using the term in its traditional sense rather than as applied under EPA's regulations) are those sites that spread wastes in layers and compact them with covering material each operating day. This procedure reduces air pollution and scavenger problems, but because these facilities are not equipped with containment, monitoring, or leachate equipment, the threat of water pollution is unmitigated. EPA states that "a small portion" of the industries studied disposed of hazardous wastes in sanitary landfills.[50]

Secure landfills segregate wastes into separate cells, prevent contamination of natural waters by wastes or waste constituents, have restricted acesss, and are continuously monitored.[51] EPA does not know the total number of secure landfills, although one 1977 study found 20 secure commercial landfill facilities and states that "a negligible portion" of industrial hazardous wastes were disposed of in secure landfills.[52]

Landfills can present two different classes of environmental problems: fires, explosions and generation of toxic fumes caused by improper handling of ignitable, reactive, and incompatible wastes; *and contamination of surface and groundwaters.*[53] Hazards of the first type can be reduced by analysis of wastes to provide information sufficient for proper management, controlled mixing or segregation of incompatible materials, and the disposal of ignitable or reactive wastes only when they have been rendered unignitable or nonreactive. Preventing contamination of ground and surface waters is more difficult. Preventive measures might include: diverting surface water run-on from other portions of the site; collecting and managing surface water run-off; equipping the facility with an impermeable liner; installing leachate collection and monitoring systems; and selecting appropriate sites for new facilities that take account of geological and hydrogeological features of the area proposed for the disposal facility.[54]

Land treatment (also called landfarming or land spreading) is the controlled application of hazardous waste onto or incorporation into the soil, so that the soil itself is the treatment medium for the waste.[55] By spreading the waste across the surface of large areas of ground (which are apt to have the appearance of agricultural fields under cultivation) and exposing it to sunlight and other proper conditions, *bacterial decomposition of organic wastes* (such as wastewater treatment sludges) can occur, *converting potentially harmful chemical compounds into inert or innocuous material.* In contrast to landfills which at best provide for safe storage of hazardous wastes, landfarms can permanently eliminate the threat of hazard. Moreover, landfarming is likely to be far more economical as a disposal method for those wastes for which it is suitable.

Land treatment is only allowed during interim status if it can be demonstrated that biological or chemical reactions in the soil will render the waste less hazardous or nonhazardous and that heavy metals and inorganic chemicals will be immobilized.[56] Moreover, sound landfarming requires careful control of soil conditions (including pH, moisture content, etc.) to prevent odor problems and assure decomposition of the waste. Sound landfarming practices must be clearly distinguished from the indiscriminate dumping of hazardous wastes onto the ground that in the past has often been described inaccurately as land treatment.

Deep well injection is an additional method which is used for the disposal of certain types of liquid wastes in some areas. In this operation waste streams are pumped down a deep well for injection into preselected geologic formations. The technology used in constructing injection wells is similar to (and largely borrowed from) methods used to drill wells for oil and gas extraction. The wastes may be injected at several hundred to several thousand feet below the surface, and ideally thick confining layers of impermeable material separate the receiving formation from usable aquifers above. Techniques for monitoring the security of the annulus (the concentric space around the injection tubing between it and the outer casing) are used to assure that no leakage occurs into formations closer to the surface. Careful analysis is required of these geologic formations and subsurface conditions in the vicinity of each well to assure that neighboring wells, faults, or other circumstances will not permit an upward migration of the wastes into usable aquifers.

Concern over possible environmental risks associated with deep well injection of waste material led to the creation of the *underground injection control (UIC) regulatory program under the Safe Drinking Water Act of 1974.* Since EPA's UIC regulations preceded its implementation of RCRA, the RCRA regulations largely defer to the UIC program. Because that is a separate regulatory program, and because deep well injection does not represent one of the principal methods for disposal of hazardous waste, it is not discussed further in this report. It is, however, highly significant in localized situations.

Resource recovery is a final category of methods for handling hazardous wastes, which from some viewpoints might be regarded as treatment or disposal or both. The feature of resource recovery which distinguishes it from treatment or disposal, however, is the recapturing of energy or materials from potentially hazardous wastes and takes three basic forms: *separation, material conversion*, and *energy conversion*.[57] Although this form of hazardous waste management accounted for less than two percent of the hazardous wastes disposed off-site by the industries studied by EPA (see Table 8), as raw material and disposal costs continue to rise, the rate of recycling and reuse should increase significantly.[58] *Separation* removes specific components from a waste stream. *Material conversion* is the transformation of a waste stream constituent into a form that is amenable to reuse or recovery. *Energy* *conversion* is the use of the wastes as an energy source by combustion or by using the waste to drive a chemical process.[59]

Hazardous waste recovery operations include: solvent reclamation; mercury reprocessing; metal reprocessing; and petroleum rerefining.[60] A 1977 EPA study identified 131 solvent reclaimers, eight mercury reprocessors, seven metal reprocessors, and 28 petroleum rerefiners.[61] Nationwide information on the specific amounts of materials recovered are very limited. In 1974, however, about 270,000 metric tons of waste organic solvents are estimated to have been reclaimed by independent solvent reprocessing operations.[62]

One other aspect of the reuse recycle approach to hazardous waste management that deserves particular mention is the waste exchange. There are two basic types of this operation: *waste information clearinghouses*, which function as interchanges through which buyers and sellers of different waste materials can learn of each other, and *materials exchanges* which physically handle and exchange wastes. With increased costs providing incentive to look to alternative sources for the disposition of hazardous wastes and for new sources of raw materials, these types of operations are growing in popularity. Whereas EPA data from a 1977 study identified eight information clearinghouses and one material exchange[63], a 1981 study found 20 information clearinghouses and three material exchanges currently in operation.[64]

Table 9 shows the manner in which the different treatment and disposal methods discussed above are integrated in handling various waste streams from one industry.

Midnight Dumping

The preceding discussion hopefully provides an appropriate survey of the current waste-handling practices of responsible American industry. It does not, however, provide by itself a complete indication of the reasons RCRA was enacted. Without wanting to give any incentive for a hoodlum to appear at my door, it may be sufficient to suggest that the honest and legitimate businesses which engage in transportation and disposal of hazardous waste have on occasion encountered competition from the less scrupulous members of our society. It is beyond the scope of this book to enumerate the indiscriminate practices and blatant abuses which all too often have occurred. Clearly, however, RCRA was enacted not only to assure that "landfills don't leak" but also to put an end to the entire sphere of activities associated with the label of "midnight dumping."

Groundwater Contamination

A Few Basic Facts About Groundwater

The most serious potential threat to human health and the environment posed by the disposal of hazardous waste is that of groundwater contamination. Groundwater, defined as the subsurface waters found in zones where the

Table 9[44]
HAZARDOUS WASTE HANDLING PROCESSES IN THE INORGANIC CHEMICALS INDUSTRY (1973)

Hazardous Waste Stream	Treatment By Generator	Reclamation		Disposal	
		On-site	Off-site	On-site[a]	Off-site
Mercury contaminated wastes	treatment for recovery	retort for mercury recovery	mercury recovery	landfill,[c] pond,[d] storage in drums	landfill
Asbestos and lead contaminated wastes	segregation and dewatering	none	none	landfill; pond	landfill
Chlorinated hydrocarbons	segregation, incineration	used in organic chemicals manufacture	none	incineration,[e] landfill; discharge to municipal sewer system	landfill
Metallic sodium and calcium sludges	not generally treated	none	none	not disposed of on-site	ocean dumping[g]
Titanium dioxide pigment production	neutralization	none	none	pond, deep-well injection[f]	landfill; ocean dumping
Chrome pigments production	neutralization and precipitation	metal recovery	none	pond; landfill	landfill
Inorganic acids manufacture	not generally treated	none	none	pond	landfill; roadfill
Fluoride manufacture	not generally treated	none	none	pond; dump; deep-well injection	landfill
Phosphorus containing wastes	settling	phosphorus recovery	none	landfill; drum storage;[g] dumping	not disposed of off-site

NOTES

[a] 84-89 percent of the potentially hazardous wastes were disposed of on-site.

[b] One-two percent of the wastes were reclaimed.

[c] Approximately 42 percent of the wastes were disposed of in landfills.

[d] 20-30 percent of the wastes were disposed of by ponding.

[e] <1 percent disposed of through incineration; one-two percent disposed of through high temperature processing.

[f] 14 percent of wastes disposed of through deep-well injection.

[g] No data on the percentage of wastes disposed of in this manner. <1 percent disposed of through municipal sewers.

spaces between soil and rock particles are fully saturated, is a major natural resource. An estimated 33 to 59 quadrillion gallons of groundwater, recharged at a rate of 300 trillion gallons per year, lie within one-half mile of the surface.[66] This is more than four times the volume of water contained in the Great Lakes.[67] Aquifers, underground formations saturated with water, that are capable of producing 100,000 gallons of water per day to a single well underlie one third of the United States.[68]

Groundwater accounts for some 45 percent of the drinking water consumed in the United States,[69] by 48 percent of the population.[70] *The importance of groundwater* as a source of supply for drinking water or to meet industrial, agricultural, or other needs *varies geographically from one extreme to the other*. Some areas of the country depend heavily or totally upon groundwater and could not function without an adequate supply of high-quality groundwater. Other areas endowed with plentiful surface waters rely entirely on them and make no use of groundwater. Typically in urban and metropolitan areas the entire water supply needs of the community are provided by either investor-owned or public water companies. These operate sophisticated water distribution systems and obtain their supplies of water from a combination of sources, which may include a mixture of groundwater wells and surface water reservoirs.

Approximately 31 trillion gallons of groundwater are withdrawn annually, about 18 percent of which is used for drinking water.[71] Groundwater withdrawals are increasing at a rate of 3.8 pecent per year in contrast to a two percent annual increase in total fresh water withdrawal.[72] Although the rate of recharge is an order of magnitude greater than the rate of withdrawal (300 trillion gallons vs. 31 trillion gallons), *in many western areas withdrawals exceed recharge, causing overdrafts.*[73] Overdrafts accounted for approximately 25 percent of all groundwater withdrawals in 1975.[74]

Groundwater is usually replenished by the infiltration of precipitation through the permeable soils of an aquifer's recharge zone.[75] In the absence of other contamination, many impurities are removed from the recharge water by soil and terrestrial microorganisms by the time it reaches the underlying aquifer.[76] Under the influence of gravity, *groundwater moves slowly* from the recharge zone to discharge to surface waters,[77] *at a rate "typically less than a few tens of feet per year*, depending on the hydraulic gradient and permeability of the aquifer."[78] If a contaminant is introduced into the groundwater, the slug of contaminant spreads out into a plume. This plume demonstrates a concentration gradient along the direction of flow and lateral to the direction of flow.[79] A study of an aquifer contaminated by the Idaho Falls National Engineering Laboratory suggests that the contamination plume disperses laterally to about the same degree as it does in the direction of flow.[80]

These characteristics create unique problems in the efforts to prevent contamination of groundwater by hazardous wastes or their constituents. *Because of the very slow movement of groundwater and the slow rate with which a plume of contaminant disperses and moves through the water, once an* *aquifer is polluted it is likely to remain polluted for a long time. These same characteristics however make it possible to continue to use the water from one part of an aquifer notwithstanding the pollution of another part.*[81] It may take a long time before groundwater contamination is noticed; decades may pass before the plume of pollution from a source of contamination turns up somewhere else in the water supply.[82]

Testing and monitoring groundwater for contamination is also difficult and costly. Since contaminants move in a plume, multiple wells are necessary to assess the quality of water in an aquifer.[83] Because concentrations of critical constituents may be in the low parts-per-billion range, methodology for analysis may be unreliable, complicating the interpretation of results.

The Council on Environmental Quality prepared a tabulation of the 33 synthetic organic chemicals most commonly found to contaminate drinking water wells in contrast with the concentration of these substances in drinking water from surface supplies. This table, excerpted below in Table 10, suggests that drinking water from groundwater may generally be more adversely affected by chemical contamination than is drinking water drawn from surface sources.[84]

Groundwater Classification and Management

Increasing knowledge about the extent of our reliance upon groundwater has produced a growing realization that a range of control strategies will be needed to shepherd this resource wisely. It is likely, for example, that more states will establish groundwater classification systems. Recognizing that not all groundwater is of equal quality or accessibility, *several states including New York, New Jersey, and New Mexico, have established groundwater classification systems* that serve as the basis for implementing other groundwater protection mechanisms.[86] Based on these classifications it may be possible to set effluent standards and impose different management

Table 10[85]
ORGANIC CHEMICALS FOUND IN DRINKING WATER WELLS

	Highest Groundwater Concentration		Highest Surface Water Concentration	
Chemical	(in ppb)	[State]	(in ppb)	[State]
Trichloroethylene	27,300	[PA]	160	[NY]
(TCE)	3,800	[NY]		
Chloroform	490	[NY]	700	[NJ]*
Benzene	330	[NJ]	4.4	[NJ]
Xylene	50	[NY]	24.0	[NY]
Vinyl Chloride	50	[NY]	9.8	[NY]
Parathon	4.6	[CA]	0.4	[CA]

* *Note:* Surface water concentrations exceeded groundwater concentrations in 3 of the 18 cases for which the CEQ tabulation presented data for both sources on the same substance.

practices and land use controls for different aquifers.[87] Because many of these issues cross political and institutional boundaries, and because there is no unified federal legislation that focuses on groundwater management,[88] it may be some time before a coordinated national strategy is developed. In the interim, persons involved with hazardous waste management will have to deal with the current piecemeal structure of federal and state regulations.

Problems of Contamination

Our country is confronted today with at least certain instances of serious groundwater contamination. The intense public anxiety and resultant political pressure for strong action to meet these problems are supported by factual developments that are certainly disturbing. A true appreciation of the real extent and nature of the threat which contamination poses to essential groundwater supplies is, however, almost totally lacking. This is the case not only amongst the general public but also within the leadership circles where government policy is established.

Even among experts, knowledge about groundwater is limited. Any popular understanding of basic facts about groundwater is almost non-existent. The ordinary layman is likely to possess a good deal of accurate information about surface water; similar information regarding groundwater is apt to be a total mystery. This pervasive ignorance has contributed to an extraordinary oversimplification in the popular perception of the threat to national supplies of groundwater. Elements of this public misconception tend to include the notions that nearly all use of groundwater is for drinking water, nearly all areas are dependent on groundwater, nearly all groundwater is contaminated, nearly all contamination is irreversible, and nearly all contamination results from improper handling of hazardous waste.

The first key to understanding the problems of groundwater contamination is to recognize the wide-ranging diversity of such problems from one locality to another. As already stated, dependence upon groundwater (or even usage of it) varies greatly among different areas. Of all groundwater used by society only 18 percent is dedicated to drinking water usage and that includes all residential or other supply where any part of the water may be used for human consumption.

The sense that nearly all groundwater is threatened with contamination is an equally misleading oversimplification. Actual occurrence of contamination is highly localized and episodic. In some spots groundwater may be seriously contaminated. In other areas it may be slightly contaminated. In vast areas of the country groundwater is of excellent quality. In 1980 EPA estimated that *up to one percent of the area of usable surface aquifers in the country may be contaminated* with pollutants that have migrated from landfills and impoundments. Since no nationwide systematic surveys have been made to document the extent of groundwater contamination, precise information on this subject is not available even to the expert.

One element of popular conception regarding groundwater contamination is reasonably close to the truth. That is the sense that such contamination is likely to be irreversible (in the absence of remedial action). Since biodegradation generally does not occur within aquifers and since the dynamics of self-cleansing operate in aquifers at so slow a rate as to be practically insignificant, *it is quite true that once groundwater is contaminated it normally stays that way*. In this regard, however, it is important to repeat that contamination within one part of an aquifer should not be equated to contamination occurring throughout the aquifer.

Finally, it is critical to place the degree of contamination resulting from hazardous waste disposal practices within a proper perspective. That must take into account contamination occurring from other sources. In point of fact, *contamination rendering groundwater unfit for human use is most likely to occur from causes other than hazardous waste mismanagement*. The sources of groundwater contamination that are predominant vary strikingly from one region of the country to another. In highly industrialized areas *hazardous waste contamination* is apt to be one of the principal elements in the picture. Inadequate residential *septic tank systems* also cause widespread contamination throughout populated regions. Many other sources of contamination also may exist, such as infiltration of *highway de-icing salts*. In rural areas agricultural practices are apt to present the primary threat to groundwater quality, including infiltration of *irrigation return flow* waters and other forms of infiltration of pesticides and fertilizer chemicals. *Mining operations, petroleum extraction, and animal feedlot wastes* all have been identified with groundwater contamination and represent significant elements in the picture in certain localities. Another serious threat to groundwater in some areas comes from *salt water intrusion*. In fact, a large portion of all aquifers too contaminated for human use are contaminated with salts attributable to *natural causes*.

A review of groundwater contamination problems in any state thus will reveal *a checkerboard picture* dotted with a wide diversity of problems attributable to varying causes. The development of sound policy to correct existing contamination and prevent future contamination obviously must address the full range of these problems in a balanced and intelligent manner.

Options for Remedial and Preventive Controls

The final element of factual information that must be taken into account as part of the foundation for a national regulatory strategy is the available control technology. Curiously, this indispensable factor in society's capacity to deal with groundwater contamination has received short shrift in nearly all public and political debates. *What would seem to be the first obvious question—namely, what can be done to correct a given contamination problem—seems to be totally overlooked until the very end of our public thought process.*

A number of basic techniques can be employed to deal with groundwater contamination. Among these a fundamental distinction must be made between those that are suitable to prevent future contamination and those that are suitable as remedial efforts. In the category fo *preventive technology* the most important methodology currently utilized in new facilities is the installation of impermeable liners (either thick layers of dense clay or plastic membranes) in combination with leachate collection systems to remove liquid collecting at the bottom of the facility and monitoring wells to assure that effective containment is occurring.

A greater variety of techniques potentially may be considered to achieve *remedial action* where contamination has already occurred. In some instances contaminated areas might be excavated, a process imposing enormous costs in addition to the problems of disposal of contaminated material. A related approach would involve installation of recovery wells to pump contaminated groundwater out of an aquifer so that it could be treated at the surface, allowing the contaminated water which is removed to be replaced by uncontaminated water within the aquifer. In some cases it may be possible to treat and decontaminate groundwater in place.

An entire set of additional technologies may be employed where groundwater has been contaminated if the purpose agreed upon is not to remove the contamination but merely to contain it. A common method of *containment* is the installation of slurry walls, grout curtains, or other impermeable barriers designed to block off the lateral movement of contaminated groundwater. The effectiveness of such methodology is apt to depend upon the existence of an impermeable horizontal layer of bedrock to prevent downward migration of the contaminated groundwater. The feasibility of installing such barriers is limited at depths much greater than 100 feet. Even within such depths, and even after the enormous expense of installing such barriers has been incurred, they may not be effective. In many cases it may be advisable to combine the installation of containment barriers with recovery wells or injection wells which alter the migration patterns of the underground water. A related approach may be to control withdrawal rates, restricting the placement of wells so that contamination does not migrate and uncontaminated parts of an acquifer can continue to be used.

Without pursuing further details in the engineering field of correcting existing groundwater contamination, it is accurate to state that this technology is in its early stages of development and application. The *technology that is currently available has many drawbacks*. It may prove unreliable. At best it is likely only to yield partial satisfaction. It is very costly. To a great extent these drawbacks are inherent in the sheer physical facts involving bodies of contaminated water distributed in tiny pores of open space deep underground. It seems unlikely that any simple cheap method can be found to deal with such circumstances.

The limitations of technology weigh heavily, however, *upon available options for cleanup of contaminated aquifers*. One probable reality has scarcely been acknowledged or even contemplated. That is that considerations of feasibility and cost may preclude any comprehensive program to achieve a complete cleanup of all contaminated groundwaters in the aquifers surrounding existing hazardous waste disposal sites. Unavoidably, however, *those practical problems must be confronted as individual cases are processed through the regulatory framework*. That prospect produces a present need to develop guidelines to identify those situations in which a maximum effort should be undertaken and to define the degree of cleanup required. It would seem obvious that such guidelines should take into account not only the severity of contamination but also the prospects whether such groundwater will be withdrawn for use and that humans may be exposed to its contaminants.

Another factor bearing upon the advisability of committing vast expenditures to the containment, removal, or treatment of contaminated groundwater in aquifers is the *possible alternative of relying upon treatment* of such groundwater before it is used. In assessing that alternative, recognition must be made that in some cases—but not all—groundwater may be withdrawn by private wells where the required treatment would not, or might not, occur.

Cutting across all of these problems is the consideration that policies developed for control and cleanup of groundwater contaminated by hazardous wastes should bear some logical relationship to comparable policies concerning groundwaters contaminated by other sources. This is especially needed since in a quantitative sense contamination from other sources is far more prevalent than contamination by hazardous wastes. Moreover, the public health effects of alternative sources of contamination (for example seepage from septic tanks) may be equally significant.

Conclusion

This brief summary of practical factors affecting groundwater contamination is merely suggestive of the complexities that must be reckoned with in establishing a regulatory framework for the management of hazardous wastes. It is by no means exhaustive or complete. Yet even this brief survey is sufficient to demonstrate the diversity of types of wastes that may be classified as hazardous; the diversity of industrial operations in which such wastes are generated and handled; the diversity of facilities at which such wastes may be stored, treated, disposed of, or utilized for resource recovery; the diversity of factors bearing upon the chances that human exposure to such contaminants will ever occur; and the diversity of practical considerations impacting the options for preventive and remedial control. These are the complexities that EPA was called upon to address when RCRA was enacted in 1976. The record of EPA's efforts to grapple with that colossal challenge has been a saga of frustration and slow progress. It is to that record that one must next turn in the quest for understanding of our present regulatory framework.

The July 23, 1982, issue of

HAZARDOUS MATERIALS INTELLIGENCE REPORT*

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Trends in waste treatment technologies

Land disposal has been the cheapest and most common method of disposing of hazardous wastes for many years. The 1976 Resource Conservation and Recovery Act (RCRA) gave the U.S. Environmental Protection Agency (EPA) the mandate to regulate land disposal in a way that would encourage treatment and destruction of wastes by other methods and make industry less dependent on land disposal. Estimates in 1981 indicated, however, that up to 80 percent of all hazardous wastes generated in the U.S. ended up in land disposal facilities.

All industry representatives contacted by HMIR agreed that, while land disposal will always be needed to handle the residues of even the most efficient destruction technologies, state and federal government agencies will be using regulatory and financial incentives in the next decade to equalize the cost of land disposal with that of other methods and thereby encourage generators to use alternative treatment technologies. HMIR sources agreed that, if costs were equivalent, generators would prefer to use methods other than land disposal in order to avoid "downstream" liability that can result from improper and even state-of-the-art land disposal.

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Hazardous waste management: on-site or off-site?

In surveys conducted during the last decade, researchers have estimated that hazardous waste generators treat or dispose of up to 90 percent of their wastes on-site. According to Joseph Mayhew of the Chemical Manufacturers Association (CMA), however, that figure may not accurately reflect current practices, because: 1) the surveys were conducted prior to EPA's "listing" of hazardous wastes under RCRA and might therefore either fail to account for all wastes currently defined as hazardous or might include wastes not considered hazardous; and 2) no survey to date has taken into account wastes generated by companies other than the 50 largest chemical manufacturers. A researcher for CECOS International Inc. of Niagara Falls, New York, told HMIR that CECOS has recently estimated that the ratio of hazardous wastes treated or disposed of on-site to wastes handled at treatment facilities or disposed of at off-site landfills is about 4:1.

Reliable projections of future demand for off-site management of hazardous wastes are even more difficult to obtain. In May, EPA released a study prepared by Booz, Allen & Hamilton Inc. of Bethesda, Maryland, which concluded that the total volume of wastes handled by the nine largest U.S. waste management firms actually declined in 1981 as compared with 1980. (HMIR, 28 May 1982, p.1.) In contrast, a report to be issued within several weeks by Arthur D. Little, Inc. (ADL) of Cambridge,

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Comments: EPA's new land disposal rules

Initial reactions among the regulated community and environmentalists to EPA's new land disposal regulations varied significantly. (HMIR, 16 July 1982, p.1.) EPA published the interim final rules, Part 264 of the RCRA regulations, in the Federal Register this week. Charles Johnson, technical director of the National Solid Wastes Management Association (NSWMA), called the regulations "tougher than anyone expected," and predicted that many existing landfills, particularly ones operated by smaller firms, will have to close because they will not be able to meet the new requirements. Johnson told HMIR that the new rules would also prevent facilities that might only be accepting small quantities of hazardous wastes from expanding their operations, because the expanded areas would then have to be equipped with the costly impermeable liners and leachate collection systems required of new facilities. Johnson also criticized the "restrictive and inflexible" requirement that liners be constructed of an impermeable synthetic material, rather than of a natural material that might be equally impermeable.

In contrast, Khristine Hall of the Environmental Defense Fund (EDF) told HMIR that, while standards for new facilities are "as good as could be expected," the standards for existing facilities are not stringent enough to ensure safe operation. Hall stressed that the regulations should not exempt existing facilities from the requirement for liners and leachate collection systems. Hall also criticized the lack of limits on toxic releases into the air from a waste facility and the lack of a requirement for corrective action in the event of such a release.

Gary Dietrich of Clement Associates, Inc. of Arlington, Virginia, former director of EPA's Office of Solid Waste and co-author of the regulations, told HMIR that, since both industry representatives and environmentalists are dissatisfied with the rules, EPA "must have the right package." Dietrich said that EPA Administrator Anne Gorsuch should receive credit for defending the stringency of the regulations during an extensive review by the U.S. Office of Management and Budget earlier this month. He also said that Hall's criticism of the exemption of existing facilities from the liner and leachate collection system requirement is partially justified, because some smaller landfills and surface impoundments could possibly be retrofitted without environmental harm. EPA had said that exhumation of wastes to install a liner in an existing landfill would create unnecessary hazards to workers and the environment.

Dietrich added that some existing facilities might actually find it cheaper in the long run to retrofit with double liner systems. A facility with a double liner would be exempt from the groundwater monitoring requirements and, because a waste release would be less likely than from an unlined facility, the retrofitted facility might avoid a costly remedial action. Dietrich supported EPA's decision not to require monitoring and corrective actions for air releases of toxic fumes, saying that there is no epidemiologic documentation of public health damage from such releases. He said, though, that EPA is researching the matter and hopes to address it at a later date.

According to Dietrich, the capital investments that will now be required to install a liner, a leachate collection system, and a groundwater monitoring system at new land disposal facilities make it probable that only the major waste management firms will be able to build new facilities. Dietrich added that the stringency of the regulations for new facilities ought to increase public confidence in such facilities and reduce local opposition to siting attempts.

However, the new rules do allow a new facility to receive an exemption from the liner and leachate collection system requirements if the facility operator can prove to EPA that contamination of groundwater or surface water will not occur because of the particular design and location of the facility. Johnson of NSWMA welcomed this exemption, saying that it will encourage waste management firms to site land disposal facilities in areas where the groundwater is either too deep to be affected by a waste release or too brackish to be usable. He said that several facilities, particularly in the western U.S., have already taken advantage of such hydrogeologic conditions. Johnson also approved of the "specific" language in the regulations defining groundwater monitoring requirements and the requirements for corrective action in the event that the groundwater standards are exceeded.

Hugh Kaufman of EPA's Office of Solid Waste and Emergency Response argued, however, that the language concerning corrective action is not nearly specific enough. Kaufman said that, because the rules provide for a case-by-case determination of what response is required to a waste release, they give facility

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operators too many loopholes to avoid corrective action. He said that there should be concrete national standards to cover all releases at all facilities to prevent the "financial and political" factors involved in cleanup negotiations from completely determining the extent of a cleanup.

EPA justified the case-by-case approach in Section 264.100, stating that "corrective action measures are highly dependent on site-specific factors" and that "EPA does not want to establish rigid guidelines for corrective action that stifle innovation" in groundwater cleanup technology. Under Section 264.98, EPA can set alternative concentration limits (ACLs) for hazardous constituents found migrating from a site, even if the concentrations are "significantly above background levels or appropriate National Interim Primary Drinking Water Standards (NIPDWS) levels." Thus, if EPA determines that the contamination at or below the ACL will not pose a threat to human health or the environment, EPA can also waive the requirement for corrective action.

Kaufman also criticized the lack of a requirement that facility operators offer assurances in their permit applications that they could pay for any needed corrective action. He said that the post-closure financial assurances cover only the "old-age" problems of a facility and that there should be financial assurances that would cover "catastrophic" accidents during the operating life of the facility. Kaufman added that, without such assurances, permitting agencies would be in the position of having to decide whether to try to force an environmentally adequate cleanup and risk having the operator "go broke and walk away," or accept a corrective action that the operator could afford but that would not necessarily be environmentally sound.

While NSWMA warned of the effects the rules could have on small firms, representatives of large chemical manufacturers and of large waste treatment firms agreed that the regulations would not drastically affect their current disposal practices. Spokesmen for Dow Chemical U.S.A. of Midland, Michigan, and Monsanto Corp. of St. Louis, Missouri, told HMIR that most large manufacturers that have on-site disposal facilities already comply with the new rules, and that, if their groundwater monitoring systems do not extend to the waste management boundaries, they could easily afford to install new wells. A spokesman for Rollins Environmental Services Inc. of Wilmington, Delaware, said that most commercial landfills also already meet the standards. Joe Boren of SCA Services of Boston, Massachusetts, told HMIR that the regulations will definitely lead to increased treatment of wastes, because the requirements for liners and leachate collection systems will triple operating costs at new landfills. Boren predicted that as many on-site landfills reach capacity in the next decade, operators would not want to expand their facilities because they would have to comply with the requirements for new facilities. According to Boren, these generators would then have to rely on off-site treatment and disposal.

California industry prepares for landfilling ban

Generators and handlers of hazardous wastes are preparing to meet the recently revised schedule for California's ban on the land disposal of untreated "high-priority" wastes — the first such program instituted in the U.S., and a potential model for nationwide legislation. (HMIR, 12 Mar. 1982, p.7.) Gary Davis of the California Office of Appropriate Technology (OAT) told HMIR that the Department of Health Services (DHS) is currently soliciting comments on draft regulations to implement the ban, and that DHS will formally propose the rules on 30 July and finalize them in November. Although virtually all HMIR sources supported the objective of reducing industry's dependence on hazardous waste landfills, many generators questioned the wisdom of setting a schedule for the ban before alternative commercial treatment facilities, which may face siting problems, come into operation. Industry sources also criticized the state's new waste disposal taxes, which they said would combine with the landfill ban to provide incentives for illegal dumping.

DHS will probably adopt the following extended schedule for phasing out the landfilling of the untreated wastes designated in Governor Edmund Brown's October 1981 executive order: 1) 31 March 1983 — wastes containing free cyanide or cyanide metal complexes at concentrations greater than 1000 milligrams per kilogram (mg/kg) wet weight; 2) 1 September 1983 — liquids containing any of 11 toxic metals and their associated compounds above specified concentrations, other extremely hazardous inorganic wastes, acids of pH 2 or less, leachable sludges containing toxic metals, and polychlorinated biphenyls (PCBs) in concentrations greater than seven milligrams per liter; 3) 1 July 1984 — pesticides, solvents, and other liquids containing halogenated organics, as well as other extremely hazardous organic wastes; and 4) 1 January 1985 — sludges containing halogenated organics. Davis said that the California Air Resources Board will also ban the disposal of liquid wastes containing more than five percent volatile organics by 1 July 1984, and liquids containing more than one percent volatile organics by 1 July 1987.

OAT has outlined appropriate alternative waste treatment and disposal technologies for each waste and has predicted that the technologies will be available by the scheduled deadlines, but the regulations

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California landfilling ban

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will not require generators to use any particular technology. Joan Berkowitz of Arthur D. Little (ADL) told HMIR that California officials are overly optimistic about the availability of treatment technologies, and that California's estimate that the annual cost to industry of using alternative treatment technologies of $30 million is probably too low. Recent ADL evaluations of waste treatment capabilities in Maryland and in the New England region claimed that at least 40 percent of the wastes generated in those areas would have to be landfilled.

As an example of the complications involved in assessing treatment capacity, Berkowitz noted that Maryland facilities had excess capacity for neutralizing acids, but that if a significant portion of the acid wastes contained as little as 10 percent added oil, a treatment shortage would occur because most facilities in Maryland do not have separation capabilities. Berkowitz said that the planned rapid implementation of the ban might encourage illegal disposal, cause industries to ship wastes out of state or relocate to other states, and force small- and medium-sized generators out of business. She added that it was ironic that California should be the first state to phase out landfilling, because evaporation exceeds precipitation in California, making the climate ideal for landfills.

John Cupps of the California Council on Environmental and Economic Balance (CEEB), a consortium of business, labor, and public-interest organizations that includes representatives of Dow, Monsanto, du Pont, ARCO, Union Oil, Getty Oil, Hewlett-Packard, and Bechtel Engineering, disputed OAT's predictions that adequate treatment facilities would be available in time for the ban and said that the state should have waited to institute the ban until the facilities had been sited and were operating. Moreover, Cupps said that the facility siting process California established in March has been delayed because Governor Brown has still not appointed personnel to the state siting council that is supposed to recommend improved siting procedures. Furthermore, although OAT had proposed to facilitate the siting of new facilities by consolidating the permits a facility must obtain from various state agencies, Cupps said that the permitting process has not been consolidated. Cupps and David Bauer, vice president of IT Corp. of Wilmington, California, also said that EPA delays in establishing regulations for waste facilities have held up the siting of new facilities in California.

California recently established a new tax of $6.52 per ton that generators must pay to have their wastes landfilled, and twice this amount, $13.04, for wastes designated as extremely hazardous. The tax, which will be recalculated every three months, based on statewide land disposal statistics, is designed to generate a $100 million "superfund" over 10 years for the cleanup of abandoned waste sites. In addition, California has increased its general fee on land disposal for all hazardous wastes from $1 to $4 per ton. Cupps claimed that, because of the new tax and the increased fee, payments by certain generators would increase from $1 per ton to $17.04 per ton, creating strong incentives for waste reduction but also for illegal disposal.

Responding to the issues raised by Berkowitz, Cupps, and Bauer, Davis emphasized that the ban will affect at most 50 percent of hazardous wastes and that it applies only to untreated wastes. Davis addressed Berkowitz's allegation of naive OAT predictions by saying that OAT had based the ban schedule on information provided by the waste management industry. He added that the new regulations will allow industry to petition DHS for extensions of the deadline during a one-month period four months before each phase-out date. DHS also will be empowered to grant emergency suspensions of each ban after it takes effect, to grant categorical exemptions for certain wastes to all generators, and to grant variances to individual generators for specific waste streams, based on site-specific considerations.

The incentive to ship wastes out of state would be counteracted by strong disincentives, according to Davis, not only because of high transportation costs but because adjacent states are considering similar approaches to waste management. Davis said that OAT has received a large number of requests for information from firms interested in establishing treatment facilities in California, and that the increased number of treatment facilities arising as a result of the ban would decrease the risk of a transportation accident involving untreated hazardous wastes. Davis also said that waste management firms operating in California, such as BKK Corp. of Torrance, California, and SCA Services Inc. had told OAT that it had overestimated the costs of using alternative technologies. Furthermore, according to Davis, S.B. 810, a bill pending in the state legislature, would provide low-interest loans to firms developing alternative treatment technologies. The California Pollution Control Financing Authority (PCFA) already provides similar financial assistance, and Davis said that three hazardous waste generators have received PCFA loans.

Davis also said that the Governor's Office of Permit Assistance (OPA) has established procedures to expedite permitting for waste treatment firms. He noted, for example, that a cement manufacturer that applied for a permit to burn hazardous wastes in its kiln received its permit within 180 days after OPA provided assistance. Davis conceded that efforts to consolidate the various permits had not been successful to date because of "turf battles" between regulatory agencies, but he pointed out that four new facilities have received permits recently in California: 1) the BKK inorganic liquid treatment facility in Wilmington; 2) the BKK treatment and transfer facility in San Diego; 3) the JJJ Co. acid neutralization facility in Vernon, which includes an oil/water separator; and 4) the cement kiln, which will incinerate non-halogenated solvent wastes in Lebec. Davis said that OAT has moved away from its former plan of encouraging the siting of a comprehensive, centralized waste treatment facility similar to the Kommunekemi plant in Nyborg, Denmark, because the political climate is more conducive to a network of smaller, specialized facilities.

The upcoming ban appears to have provided a statewide impetus for recycling, according to HMIR sources. Peter Schneider of Romic Chemicals, a solvent reclamation firm in East Palo Alto, said that the ban gave clear incentives to recycle materials. Maureen Frisch of TRW, Inc. of Cleveland, Ohio, told HMIR that, partly because of the ban, TRW plans to install its own $500,000 treatment facility to pre-treat all of its rinsewater before discharge and to stabilize chromium wastes. While it is acknowledged that the ban will create a greater incentive for illegal waste disposal, some HMIR sources said that increased enforcement efforts on the part of the state and local governments will help prevent an outbreak of "midnight dumping." Angela Bellomo, coordinator of the Toxic Substances Control Program (TSCP) of the Los Angeles County Department of Health Services, told HMIR that the county has just allocated almost $1 million for a 23-person inspection force to ensure generator compliance with hazardous waste regulations and with the ban when it takes effect. Last year, investigations of 800 of the county's 20,000 generators found that 30 percent of the generators had violated the RCRA regulations in some way. Bellomo said that 35 cases have already been referred to the district attorney and that eight completed cases have so far resulted in more than $200,000 in fines.

Treatment technologies *continued from page 1*

Changes in the types of waste streams generated in the U.S. may also affect the types of treatment technologies that are used. Geraldine Cox of CMA told HMIR that U.S. petrochemical manufacturers are beginning to move these plants to areas in which petroleum resources are less expensive than in the U.S., such as Saudi Arabia. Cox said that this trend would eventually lead to a significant decrease in the amount of organic wastes generated in the U.S. In addition, according to Cox, many feedstock manufacturers are entering the market for low-volume "specialty" chemicals, such as lubricants and chemical catalysts, which are currently produced primarily by specialized companies using bulk chemicals generated by the feedstock companies; she said that the feedstock companies would be able to manufacture the specialty chemicals directly with less generation of organic waste. John Schofield of IT Corp. told HMIR that increased use of electroplating and acid-etched circuitry in the computer industry will increase the amount of inorganic wastes contaminated with heavy metals. Schofield said that waste treatment firms would have to shift their focus to technologies for treating inorganic wastes if inorganics become the dominant type, which, he said, would be a reversal of the current situation.

Most HMIR sources agreed that the most efficient destruction technology available now and in the near future is incineration. Because incinerators are so expensive, however, they will likely continue to be operated primarily by large generators or large waste treatment firms. Robert Gregory of Rollins Environmental Services said, that within the next few years, Rollins hopes to use heat generated from incinerators in the form of steam to drive other treatment processes at its facilities, processes that now require costly fuel or purchased steam to operate. Rollins also plans to provide heat from its incinerators to local electrical power plants, as does SCA Services at its new chemical waste incinerator in Chicago, Illinois. (HMIR, 28 May 1982, p.8.) George Kush of SCA said that recovering heat from incinerators could bring down the overall cost of incineration to a level that is competitive with landfilling.

HMIR sources predicted that incineration of organic hazardous wastes in cement kilns will become more widely applied as EPA begins to permit facilities under the new incineration regulations. Earlier this year, Alpha Portland Cement Co. of Cementon, New York, concluded a trial burn using hazardous wastes as auxiliary fuel in the firm's kiln. (HMIR, 12 Feb. 1982, p.8.) A company spokesman told HMIR that Alpha Portland hopes eventually to fuel the kiln exclusively with waste solvents, replacing the coal used currently, at a rate of up to 70 gallons (1 gallon = 3.785 liters) of waste solvents per minute. At that rate, the waste could generate up to 420 million BTUs per hour while being destroyed at temperatures of up to 3000°F. By comparison, SCA's new incinerator in Chicago, which will be the world's largest commercial incinerator once it is permitted and operational, will destroy up to 35,000 gallons of wastes per day at up to 2300°F, producing up to 120 million BTUs per hour. There are approximately 20 wet-process cement kilns in the U.S. that potentially could incinerate hazardous wastes, but HMIR sources believe that only

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about half of them are located in regions where enough hazardous wastes are generated to make the benefits of burning the waste as fuel worth the transportation costs to the kiln.

Another dominant trend developing for generators and treatment firms will be increased use of stabilization, solidification, and fixation of wastes prior to land disposal. This trend may be encouraged by changes in state and federal regulations affecting land disposal. While the land disposal rules announced by EPA last week do not include any restrictions on landfilling specific wastes, a bill currently before the U.S. Senate as a possible amendment to RCRA, S.2644, would ban the land disposal of certain toxic wastes unless they are first treated. (HMIR, 2 July 1982, p.1.) Some states, such as California, have already announced their own restrictions on land disposal (see article on page 3).

Ron Buchanan of Conversion Systems, Inc. of Horsham, Pennsylvania, said that processes that involve chemically reacting siliceous materials such as fly ash with alkaline materials such as lime to form a waste-encapsulating cement will become increasingly important. The encapsulated wastes form a compressed solid object with a permeability of 10^{-7} centimeters/second. Gregory said that Rollins will be stressing encapsulating wastes in a molten glass, plastic, or asphalt matrix, a fixation process that according to some sources can render a hazardous constituent permanently inert. Several solidification processes, such as the one recently developed by Kipin Industries, Inc. of Coraopolis, Pennsylvania, can also produce fuel out of certain wastes. (HMIR, 4 June 1982, p.7.) The Kipin process converts organic, combustible wastes into a dust-free and waterproof fuel that costs approximately $20 per ton.

Jack Lurcott of Browning-Ferris Industries (BFI) of Houston, Texas, told HMIR that treatment firms that employ a fixation method to make a hazardous waste non-hazardous for disposal in a sanitary landfill might be "wasting time" and money, because many sanitary landfill operators might not trust fixation technologies and so might not accept such a waste, even if EPA takes it off the hazardous waste list. Lurcott said that the most cost-effective way to use a fixation or solidification method is to identify a point in the process at which the waste becomes basically inert. By stopping the process at that point, Lurcott said, the treatment firm could save the high costs of subsequent treatment stages that achieve only questionable benefits.

Other HMIR sources predicted, however, that this wariness to use solidification technologies would eventually be overcome. Sven Duering, president of Soil-Recovery Inc. of Morristown, New Jersey, said that the process marketed by Soil-Recovery produces a material considered so innocuous in Sweden and West Germany that it is used in road building in those countries. (HMIR, 27 Feb. 1981, p.8.) The Soil-Recovery process encapsulates waste in a dry powder formed from calcium hydroxide, creating a highly compactible, hydrophobic solid with a permeability of 10^{-7} centimeters/second. Duering said that Soil-Recovery is currently using the process in the U.S. primarily to treat waste lagoons.

On-site or off-site?

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Massachusetts, predicts that the percentage of wastes disposed of off-site will increase steadily over the next decade, because generators will want to turn over their wastes to specialized waste management firms which, according to ADL, are more likely to use the most advanced treatment technologies.

Waste management industry and chemical industry representatives interviewed by HMIR differed predictably on the subject of future demand for off-site treatment and disposal services, with waste management firms optimistically projecting increased demand and chemical companies stressing their own on-site waste management efforts. Most sources agreed, however, that waste generators are developing more sophisticated disposal strategies. In particular, generators tended in the past to select a single disposal method such as landfilling for all of their wastes; they are now choosing technologies, whether on-site or off-site, that are most appropriate for individual waste streams.

One factor that may cause generators to rely more on their own treatment and destruction technologies is the increasing evidence that landfills are not leakproof. David Graham, an attorney for Velsicol Inc. of Chicago, Illinois, said that the case of the SCA Services landfill in Wilsonville, Illinois, demonstrates that even government permits do not provide protection against liability for contamination caused by a leaking landfill. SCA is currently beginning to comply with an Illinois court order to exhume all of the more than 100,000 drums of wastes from the Wilsonville landfill, at an estimated total cost of $24.5 million. (HMIR, 2 July 1982, p.7.)

Other HMIR sources said that the rising prices of off-site waste management are encouraging generators to find alternatives to off-site disposal. According to the Booz-Allen report, commercial landfilling prices increased by 50 percent in 1981. The Booz-Allen researchers found that, in response, generators are not only shifting to on-site waste management but are also reducing hazardous waste volumes by segregating hazardous from non-hazardous wastes and by modifying production processes.

At least one major U.S. chemical company, Dow Chemical, has treated and disposed of virtually all of its wastes on-site for the past 30 years, in an effort to avoid involving other parties and to control its liabilities. Gary Hamlin of Dow said that Dow has stressed thermal destruction rather than land disposal; he claimed that less than one percent by volume of Dow's chemical wastes ends up in the ground. Hamlin acknowledged that only large manufacturers have the financial resources to operate on-site incinerators. However, while most generators of smaller volumes of wastes are expected to continue to rely primarily on off-site treatment, industry sources claimed that even small generators will in the next few years begin chemically treating and solidifying their wastes on-site in order to eliminate the hazardous characteristics of the wastes and to allow the wastes to be disposed of in a sanitary landfill.

Waste management industry officials believe that other factors will offset the rising prices of commercial waste disposal and the generator fear of "downstream" liability and help maintain a steady demand for off-site waste management. John Schofield of IT Corp. said that the fear of downstream liability applies only to land disposal, not to commercial treatment and destruction facilities, and that most generators will continue to trust treatment firms with which they have dealt before. Schofield told HMIR that the emphasis on waste reduction may actually benefit the commercial waste management firms, as many generators which are reducing their waste production will not find it economically feasible to treat the declining volume of wastes on-site. Schofield added that since waste reduction and reclamation methods that are built into a manufacturing process tend to remove water or other non-hazardous substances from the waste stream, generators will probably want treatment firms to handle the resulting concentrated residues.

Charles Leighton of Chemical Waste Management Inc. of Oak Brook, Illinois, told HMIR that generators will also rely more on off-site treatment now that EPA has promulgated regulations for land disposal. Sources in both the chemical industry and the waste treatment industry agreed that the land disposal rules may increase the cost of landfilling by up to three times its current unit cost, which will in turn encourage development of alternative methods of waste treatment. Leighton said that, as the treatment industry grows, independent treatment firms will have more adequate facilities, better research laboratories, and more qualified personnel than generators to handle the hazardous wastes.

Leighton argued that the treatment industry must do the research necessary to produce new waste management technologies if it wants to increase demand for its services. But other sources in the industry said that the burden of developing alternative technologies will fall on the large chemical manufacturers which are best able to fund such research. Jack Lurcott of BFI told HMIR that BFI believes that the trend in waste management is toward on-site treatment, and that BFI will therefore do little research into new treatment methods, instead concentrating on providing landfills for inorganic solid residues from generator-operated treatment processes. Ron Buchanan of Conversion Systems said that generators have an incentive to develop new treatment methods that will save them money, and that they could then license treatment firms to market the new technologies. One example of such an arrangement is the recent agreement between E.I. du Pont de Nemours and Co. of Wilmington, Delaware, and Zimpro Co. of Rothschild, Wisconsin, under which DuPont sold Zimpro the rights to its technology for detoxifying sludges with microorganisms and powdered activated carbon. (HMIR, 14 May 1982, p.7.)

Cooperation between generators and treatment firms may also take other forms. Although few major chemical companies are expected to make their on-site facilities available to other generators, George Kush, vice president of environmental affairs for SCA Services, told HMIR that he believes that large chemical waste generators will begin contracting with treatment companies to build and operate treatment plants at the generators' facilities, wherein the treatment firm would also be allowed to accept wastes from other generators. Kush said that such an arrangement, which SCA is currently considering, would be beneficial to both parties, because it would eliminate the generator's off-site transportation costs, and the dependable supply of wastes generated on-site would enable the treatment firm to attract as regular clients those generators producing a waste stream that the "host" generator's wastes could neutralize. The treatment firms might also benefit from the fact that public opposition to the construction of on-site facilities has been found to be less intense.

Ken Malinowski of CECOS told HMIR that CECOS may set up transfer stations during the next several years in areas in which a large number of small generators are located. CECOS would regularly collect wastes from the generators, store them at the permitted transfer station, and ship them to the firm's main treatment facility when enough wastes have been collected to make the transport and treatment economical. Walker Banning of the Northeast Industrial Waste Exchange in Syracuse, New York, argued for the development of regional treatment facilities operated by partnerships of treatment firms and small generators. Banning said that such facilities, which would accept only locally generated wastes, might face less public opposition than larger facilities.

Overview: Land disposal

Land disposal has, in the past, been the preferred method of dealing with hazardous wastes, primarily because it has been inexpensive. According to EPA, 527 hazardous waste landfills, up to 80 percent of which are located on waste generators' sites, notified EPA in the fall of 1980 and received interim status under RCRA. Charles Johnson of NSWMA told HMIR that there are probably slightly fewer landfills operating today. Recent evidence that no type of liner exists that will permanently contain leachate in a landfill has prompted the chemical manufacturing and waste treatment industries to look toward means of treatment and disposal other than landfilling.

Last week, EPA promulgated its interim final regulations under RCRA for land disposal of hazardous wastes (HMIR, 16 July 1982, p.1); industry sources agreed that the new regulations, which one source said will increase the cost of landfilling by up to threefold, will encourage alternative methods of treatment and disposal. Spokesmen for CECOS and BFI told HMIR that, depending on the characteristics of a particular waste and the treatment it requires prior to disposal, land disposal costs range from about $30 per 55-gallon drum and $25 per bulk ton for relatively insoluble inorganics to about $200 per drum and $280 per bulk ton for highly soluble wastes such as cyanides.

EPA said that the groundwater protection strategy embodied in the new rules is based upon the assumption that any liner will eventually leak, and that EPA views the function of liners to be a "barrier" to "facilitate the removal of liquids" from a facility. In light of this, HMIR sources indicated that, while researchers will continue to try to develop increasingly impermeable liners, land disposal research will focus on developing technologically-improved leachate collection systems to collect and discharge the leachate before it can contaminate groundwater beneath a facility, and on improving the design of caps to prevent water from infiltrating a landfill after the landfill's closure.

Jim Scharch of Residuals Management Technology Inc. (RMT) of Madison, Wisconsin, a consulting firm specializing in landfill design, told HMIR that RMT is encouraging facilities to consider the "overview" of landfill design instead of concentrating on one specific component, such as a bottom liner or a leachate collection system. Scharch said that, since it is a "foregone conclusion" that all man-made components will eventually fail, leachate containment can best be achieved through a multi-component system that includes several stratified liners, some of which can be more accessible for repair than a single liner at the very bottom of a landfill. RMT also recommends the use of temporary covers during the operating life of the landfill in order to prevent moisture infiltration and the use of monitoring systems above and below the landfill liner in order to obtain more accurate estimates of leachate flow.

Overview: Solidification

In the light of recent documentation that landfills will not adequately contain many liquid hazardous wastes over the long term, HMIR sources say that solidification of wastes prior to disposal will become an integral part of land disposal. Solidification is well-suited to sludge wastes that cannot be burned, such as inorganics and heavy metals, but is currently limited to those wastes because, according to Ron Buchanan of Conversion Systems Inc., organic solvents can volatilize under most solidification processes.

Many generators and waste treatment firms are beginning to combine solidification with neutralization processes as well as with fixation methods to ensure the impermeability of the waste, in the hope of having the treated waste taken off EPA's hazardous waste list. Methods of solidification generally involve: 1) reacting a waste with hydrophobic lime to produce a powdery material that can be compacted into a hard mass with a permeability as low as 10^{-7} centimeters/second; 2) combining a waste with cement powder, which then hardens into cement when it reacts with the liquid portions of the waste; or 3) combining lime with fly ash and wastes to form a crystalline encapsulate mass that also renders a waste structurally stable.

Another common process, used to treat wastes containing residual organics, involves a twin-screw extruder/evaporator that squeezes out excess water and the volatile organics from the waste, allowing the liquids to be recycled while the remaining solid portions are compressed into small particles and bound in asphalt. The final product can be a non-hazardous solid that can be disposed of at a municipal sanitary landfill, reducing disposal costs by up to a factor of four. According to HMIR sources, many solidification processes can treat a waste for as little as $1 per gallon.

A spokesman for Stablex Inc. of Radnor, Pennsylvania, told HMIR that stabilization by adding inert "filler" materials and solidification by adding harder impermeable materials such as cement and asphalt will guarantee the physical stability of the treated wastes, but not necessarily their chemical stability.

According to Stablex, chemical fixation prior to solidification provides the only guarantee that a treated waste will be non-hazardous and suitable for delisting. Stablex is building a fixation plant in Montreal, Quebec, and that plant will be the first in North America to use a technology that EPA has approved as a method of rendering hazardous waste non-hazardous. Ken Kazarian of BKK Corp., said, however, that fixation is unnecessary to safeguard usable groundwater in areas, such as parts of California, where the aquifer beneath a landfill may be deep and brackish.

Besides the above conventional methods, researchers at Battelle Pacific Northwest Laboratories in Richland, Washington, are developing a technique for using an electrical current to solidify chemical or radioactive wastes *in situ* at waste sites and chemical spills. (HMIR, 31 July 1981, p.8.) An electrical current passes between two graphite electrodes placed in the contaminated soil, and as the temperature in the electrodes rises to up to 2000°C, the soil melts, destroying any organics and dissolving any radioactive wastes. According to the researchers, the molten soil, when cooled, is as durable and non-leachable as glass. Battelle predicted that the process could treat contaminated soil for about $10 per cubic foot.

Overview: Thermal destruction

A recent report by the California Office of Appropriate Technology (OAT) cites the following reasons, among others, why incineration has become a major technology for the destruction of organic hazardous wastes: 1) most forms of liquid organic waste can be destroyed by incineration; 2) incinerators can generally handle much larger amounts of wastes than other treatment technologies. The OAT report said that a capacity of 10 tons of waste per hour is "not uncommon for some incinerators"; 3) heat generated by incineration can be used to produce steam and electricity; and 4) incinerators require less land area than land disposal and other treatment facilities. The limits on the use of incineration include the following: 1) incineration costs much more than other waste management technologies, especially landfilling; 2) inorganic wastes and heavy metals are not suitable for incineration; 3) incineration leaves an ash as a byproduct that has to be disposed of at a hazardous waste landfill; and 4) extensive air pollution control and monitoring equipment is necessary at the stacks. A spokesman for Rollins Environmental Services, one of the leading U.S. incineration firms, told HMIR that the cost of incinerating hazardous wastes ranges from about $0.[illegible]0 per pound (1 pound = 0.454 kilogram) to up to $0.25 per pound, depending on the waste.

OAT estimated in its report that there are about 340 thermal destruction facilities in the U.S., of which all but 12 are located on a waste generator's site. Liquid-injection incinerators, the most common type of hazardous waste incinerator, can destroy a wide range of wastes, but only those that are pumpable liquids. Rotary kilns cost more to operate than liquid-injection systems, but can destroy solid, liquid, and gaseous wastes. According to a recent study by Booz, Allen & Hamilton, Inc. of Bethesda, Maryland, the nine major U.S. waste management firms added no significant new incineration capacity in 1981. But this summer, SCA is testing its new 120 million BTU-per-hour incinerator in Chicago, Illinois, which will be the world's largest commercial incinerator. (HMIR, 28 May 1982, p.8.)

Many treatment firms and generators favor incinerators because they can accept a wide variety of wastes and, unlike the more waste-specific technologies, do not require detailed research on optimal destruction conditions or compatibility testing and do not require generators to divulge proprietary information. A Rollins representative said that no extensive research and development is needed on the destruction technology itself. He said that researchers are now developing more efficient emissions control systems to remove a greater percentage of the particulates from the stack gases, thereby increasing the types and quantities of wastes that can be incinerated. Rollins recently installed a $4 million scrubber at its Baton Rouge, Louisiana, facility that will remove microparticulates from highly chlorinated hydrocarbons which could otherwise not be burned at the facility.

Pyrolysis, a new anaerobic incineration, is a different type of thermal destruction that allows burning of mixtures contaminated by inorganics. Midland-Ross Corp. of Toledo, Ohio, has developed a pyrolysis system for burning organic sludges contaminated with inorganic salts or heavy metals at temperatures of up to 1600°F. The organics are volatilized for subsequent destruction at over 2000°F, and the inorganics are converted to an ash. The process can handle up to 11,000 pounds of wastes per hour and can generate up to 30,000 pounds of usable steam per hour.

The cost of landfilling is expected to rise as EPA implements its new performance standards for land disposal facilities, and this trend should make incineration a more attractive disposal alternative. Industry sources said that demand for incineration would also increase significantly if EPA or Congress decides to end the present regulatory exemption for wastes burned as fuel in industrial boilers. Last month, EPA decided to apply the same regulations to existing incinerators as were already in effect for new incinerators, despite allegations by the chemical industry that many existing on-site incinerators could not meet the 99.99 percent destruction and removal performance requirement. (HMIR, 25 June 1982, p.1.)

Overview: Chemical/physical treatment

Although traditional methods of chemical and physical treatment dominate processes used by hazardous waste management firms, modifications are continuously being implemented to reduce the volume of wastes that require treatment, the energy demands of the treatment processes, and the volumes of raw materials needed to achieve detoxification. Charles Leighton of Chemical Waste Management (CWM), Inc. told HMIR that CWM recently installed a new decanting system at its treatment facility and landfill in Emille, Alabama. Leighton said that a "substantial" investment was involved, and that the new unit will be able to safely pierce drums containing wastes, withdraw the wastes, and shred the drums for landfill disposal; the wastes will then be centrifuged to consolidate the solids. All of the waste handling operations will be conducted behind an explosion-proof containment system. According to Leighton, CWM's investment exemplifies how the industry has made a substantial effort to perfect simple physical waste reduction processes. Leighton told HMIR that CWM's new research and development facility at Riverdale, Illinois, plans to begin examining new techniques for the oxidation of cyanides and sulfides.

Banks Clark, manager of the SCA Chemical Services Co. facility in Newark, New Jersey, told HMIR that his plant began operation approximately five years ago, collecting wastes generated by other SCA facilities and mixing matched wastes to achieve chemical neutralization. Clark said that the facility carries out standard reduction reactions on chrome waste and neutralization on selected biocides, but SCA prefers to concentrate on chemical treatments for such specialized materials as antimony pentachloride. Clark also said that the Newark facility plans to install a proprietary process that will be capable of stabilizing extremely high concentrations of ammonium sulfide and converting it into a polymeric solid.

SCA has also developed a process that combines high-temperature distillation of organics with a useful neutralization reaction. "Lean waters," which are aqueous wastes that contain organics and have low flashpoints, such as gasoline tank residues, are mixed with strong acid in a glass-lined reactor vessel to break any emulsion present between the aqueous and the organic phases. The mixture is then neutralized with ammonia or a strong base such as sodium hydroxide. The heat of neutralization alone allows the separation of organics, since the heavy fuels remain in the reactor vessel and the lighter organics volatilize and are collected in a condenser. Both of the fuels are then reclaimed. Clark said that in some situations, waste alkaline materials can even be used to neutralize the acids, thereby treating two types of wastes in one process. Clark added that the Newark facility has recently installed a new drum handling facility in order to provide bulking services so that small and medium-sized generators can take part in these treatment operations.

A number of on-site facilities have recently made efforts to match hazardous wastes in order to achieve cost-effective chemical neutralizations. Tricil Ltd. of Mississauga, Ontario, has developed a method of using liquid inorganic alkaline wastes to neutralize hydrochloric and sulfuric acids present in flue gas at Tricil's hazardous waste incinerator in Sarnia, Ontario. Tricil currently purchases raw materials to neutralize the acid. (HMIR, 2 Apr. 1982, p.8.) Noranda Mines of Noranda, Quebec, and National Asbestos Corp. (NAC) of Thetford Mines, Quebec, plan to construct a $1 million pilot plant in Noranda to combine sulfur dioxide emissions from the Noranda Mines smelting stacks with NAC's asbestos waste streams to form magnesium sulfate for use in the pulp and paper industry, as a fertilizer, or in the production of magnesium. (HMIR, 11 June 1982, p.8.)

Overview: Biological detoxification

The use of living microorganisms to detoxify wastes has begun to expand during the last few years, due to technological improvements as well as to an increased acceptance of the applicability and cost-effectiveness of this technology, once viewed with apprehension. The most significant improvements in the field of biological treatment involve better techniques of selecting and cultivating strains of bacteria that degrade specific wastes and an increased understanding of how to control the environments in which the bacteria thrive. John Zikopoulos of Polybac Corp. of Allentown, Pennsylvania, told HMIR that a fundamental shift has occurred in attitudes within industry as people stop thinking of biological detoxification as a mechanical engineering system with the added unreliabilities of living organisms, and begin to perceive it as an extremely effective process when properly controlled.

Zikopoulos stressed that, although some bacteria respond in the same way that humans do to broad-spectrum toxins, many species can subsist and even thrive on chemicals such as cyanide that are poisonous to humans. As examples of other toxic wastes that are readily biodegradable, Zikopoulos mentioned pentachlorophenol, phosphorus pentachloride, formaldehyde, o-chlorophenol, acrylonitrile, and some chlorinated alkanes. He noted that biological treatment units are now being used to clean up contaminated aquifers, to treat hazardous wastewaters, to detoxify chemical spills on the surface, and to degrade toxic residues inside of tank trucks.

Recombinant DNA and genetic engineering technologies are now being explored in addition to the traditional adaptive mutation techniques used to create desired characteristics in bacteria. George Pierce of Battelle Columbus Laboratories in Columbus, Ohio, told HMIR that it may be possible to isolate genes in one bacterium which produce enzymes that degrade a specific waste, and transfer the genes to another organism better suited to a particular environment. Pierce and Zikopoulos both said that the success of biological treatment systems ultimately depends upon their integration with engineered systems as a whole. Although by law genetically engineered organisms are not allowed to be dispersed into the environment, Polybac already has systems that use fixed-film media and glass beads, manufactured by Corning Glass Co., to immobilize the bacteria in treatment units. Polybac intends to expand into genetic engineering this fall when it centralizes its research facilities in Allentown.

Zikopoulos told HMIR that clients have learned how to keep biological systems flourishing by continuously controlling factors such as pH and temperature. Pierce told HMIR that U.S. Steel had established a very stable system for degrading phenolic and cyanic wastes at its facility in Monroeville, Pennsylvania. Thomas Zitrides, Polybac's president, said that biological detoxification systems are also being used to treat hazardous waste streams at a facility owned by Occidental Chemical Corp. in Buffalo, New York. Chronic contamination problems were reportedly reduced significantly by treating the wastes in the biological treatment unit before passing them through an activated carbon unit. Pierce pointed out that, although microorganisms cannot detoxify all PCBs, they can degrade about 40 percent of the less highly chlorinated PCBs in a mixture such as Arochlor 1254, and could thereby significantly reduce subsequent disposal costs. Kurt McDowell of Polybac said that Polybac's largest treatment system, which costs $100,000, treats 150 pounds per day of biological oxygen demand (BOD) with 150,000 gallons per day of water flow. Polybac's smallest unit, which treats two pounds per day of BOD and processes 2000 gallons per day, costs about $10,000.

Overview: PCB detoxification

The number of PCB disposal technologies has increased significantly in the past few years. M.M. Dillon, Ltd. of Toronto, Ontario, recently completed a report for Environment Canada that identifies 81 different PCB destruction systems that have either already been proven or merit consideration. The systems are grouped into the following categories: conventional incineration, variations on incineration, chemical detoxification, and physical-chemical technologies. Ken Childs of Environment Canada told HMIR that Environment Canada expects by late August to complete verifying the information on the processes, including their operating features, the levels of destruction they achieve, the location of facilities at which they have been used, and the cost of applying them.

Within the U.S., successful PCB destruction technologies have for the most part involved either high-temperature incineration or sodium-based dechlorination processes. Arch Pettit, president of ENSCO, Inc. of El Dorado, Arkansas, which operates the only commercial incineration facility in the U.S. that handles PCB-contaminated solids, told HMIR that ENSCO is in the process of expansion and diversification. Pettit said that ENSCO plans to add an additional rotary kiln which employs the same form of hydrosonic jet scrubbers as its currently operating units. ENSCO has also been negotiating with a Japanese firm on a possible contract to produce a mobile PCB incineration unit using ENSCO technology. The firm also plans to build its own secure landfill for disposing of incinerator ash, which it currently ships off-site. Finally, ENSCO recently obtained a license from Dow Chemical Corp. to market "imbiber beads" that can selectively absorb PCBs and other hazardous materials, which become chemically bonded to the beads, rather than merely adsorbed onto the sorbent matrix.

Barney Wander of Rollins Environmental Services, Inc. told HMIR that Rollins conducted test burns of PCB-contaminated solids during the past week at its rotary kiln incinerator in Deer Park, Texas. The Deer Park facility at present accepts only PCB liquids, but Wander said that Rollins expects to receive its permit to incinerate solids this fall. There are currently seven on-site facilities that EPA has approved for incineration of PCBs: two General Electric Co. facilities in Waterford, New York, and Pittsfield, Massachusetts; three Dow Chemical facilities in Freeport, Texas, Oyster Creek, Texas, and Plaquemine, Louisiana; the La Porte Chemical Corp. plant in La Porte, Texas; and the Merton Associates facility in Chicago Heights, Illinois.

A further trend in PCB incineration is toward the development of mobile incinerators and treatment units, which eliminate waste transportation costs and presumably provoke less public opposition than permanent facilities. EPA is now planning field tests of a unit developed by MB Associates of San Ramon, California, to incinerate pure PCBs. (HMIR, 7 May 1982, p.8.) A second mobile unit, developed by

Pyro-Magnetics Corp. of Whitman, Massachusetts, has already, according to Pyro-Magnetics, achieved a PCB destruction efficiency of 99.999943 percent, and Pyro-Magnetics expects the unit to be approved by all 10 EPA regions in the near future.

In addition to these incineration facilities on land, Chemical Waste Management (CWM) has conducted a test burn of 700,000 gallons of PCBs on its incinerator ship, the M/T Vulcanus, in the Gulf of Mexico. (HMIR, 16 July 1982, p. 8.) CWM is awaiting EPA approval to burn an additional 2.8 million gallons, and has also applied for permits to burn other wastes, such as Silvex and DDT. One industry source claimed that at-sea incineration would never be cost-effective because of high transportation costs and because it would not be possible to recover energy, however, CWM has announced that in 1983 it will launch the M/T Vulcanus II, its second incinerator ship.

ACUREX Waste Technologies, Inc. of Mountain View, California, has received approval from all but one EPA region for a mobile treatment unit that uses a sodium-based chemical dechlorination process. A spokesman for ACUREX told HMIR that the company recently demonstrated that its unit can successfully treat transformer oil containing up to 17,000 parts per million (ppm) PCBs, reducing the PCB concentration to less than two ppm. The ACUREX system is similar in concept to the processes used by SunOhio of Canton, Ohio, which just recently received approval for its unit from all 10 EPA regions, and the technology developed by Goodyear Tire and Rubber Co. of Akron, Ohio. All of these units have the advantages of being mobile, of not producing any hazardous emissions or byproducts, and of not destroying the treated liquid. HMIR sources said that many PCB-contaminated transformers contain naphthalene-based oils, which have excellent dielectric properties and which are more than twice as costly as asphalt-based oils. For these transformers, chemical processes that recover usable oil are seen as more advantageous than those which burn the valuable oil as fuel. Chemical detoxification processes for PCBs cost between $2 and $10 per gallon.

Under an October 1980 order issued by the U.S. District Court in Washington, D.C., EPA is reconsidering its 50 ppm cutoff for regulating PCBs under the Toxic Substances Control Act, as well as its designation of certain PCB equipment as "totally enclosed" and therefore safe for use. EPA recently proposed to require a phase-out of PCB capacitors within 10 years, and also to stop regulating the disposal of PCB articles containing less than 500 ppm PCBs.

Overview: Resource recovery and recycling

Despite the economic and social incentives favoring treatment of hazardous wastes to recover recyclable materials, widespread application of recovery and recycling technologies in the U.S. is currently limited by two factors: 1) EPA's decision to subject wastes destined for "beneficial reuse" to full regulation under RCRA. This stance is one of the remaining points of contention in the *Shell* v. *EPA* RCRA permitting litigation; and 2) the common belief that recycled materials are likely to contain contaminants, which discourages their commercial marketing. On-site recycling facilities have the advantages of internal controls over contamination and economic benefits, but are still faced with the disincentives of what most recyclers consider "over-regulation."

Stacy Daniels of Dow Chemical cited his company as a victim of "over-regulation." Daniels said that for the past 15 years, Dow has burned halogenated wastes in its industrial furnaces and recovered hydrochloric acid, and EPA has continued to regulate this process under RCRA. Joe Mayhew of CMA claimed that recovered hydrochloric acid and reducing agents generated in the manufacture of paper are two major examples of materials that cannot be sold competitively with virgin materials because of the regulatory paperwork required by EPA.

Commercial recyclers, on the other hand, claim that other aspects of EPA's programs are adversely affecting their businesses. Dennis Lynch, president of the Resource Investment Recovery Institute of St. Louis, Missouri, a consulting firm specializing in recycling, told HMIR that business in the recycling industry is depressed because new EPA regulations, such as those governing the incidental manufacture of PCBs, allow generators to monitor their own operations and reduce the incentive to turn to recyclers. Lynch also said that reduced EPA enforcement of other hazardous waste treatment and disposal methods and decreasing prices for some metals and chemical feedstocks are also affecting the industry. Walker Banning of the Northeast Industrial Waste Exchange added that EPA's decision to regulate independent recyclers as "disposal facilities" attaches a needless "social stigma" to their operations.

James McCutchan of Harding-Lawson Associates of Houston, Texas, told HMIR that only a small percentage of customers have requested the more expensive fractional distillation services that provide purer end products than do recyclers using "low-end" technology. Lynch said, for example, that Mallinckrodt, Inc. of St. Louis, Missouri, recently declared that the methyl isobutyl ketone it is now purchasing from Foremost-McKesson Inc. is superior to virgin product.

MANAGEMENT OF HAZARDOUS INDUSTRIAL WASTES: RESEARCH AND DEVELOPMENT NEEDS

Report of the
Committee on Disposal of
Hazardous Industrial Wastes

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

The report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which established the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

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INTRODUCTION

Hazardous industrial wastes, as defined by the Resource Conservation and Recovery Act (RCRA) of 1976 (Public Law 94-580), consist of ignitable, corrosive, reactive, or toxic materials. These hazardous wastes account for 10 to 15 percent of all industrial wastes or about 35 to 40 million metric tons per year, a quantity that is growing about 3 percent per year (Maugh 1979). The study that resulted in this report represents recognition by the study's sponsors--The American Institute of Chemical Engineers (AIChE) and the Environmental Protection Agency (EPA)--that better and more environmentally sound treatment and disposal options must be available for these hazardous industrial wastes. Specifically, the sponsors requested that presently available waste disposal technologies be examined to identify their limitations and that research needed to support the development of new and improved methods be recommended. Emphasis was to be on new technologies for managing hazardous wastes, but existing technologies were to be considered where specific needs have been identified.

Hazardous industrial wastes can be considered to be all the by-products of an industrial facility that have no apparent use or value and that can pose an unacceptable risk to people and the environment if discarded carelessly. The committee conducting this study, however, believed that this definition was too broad and chose to limit the type of wastes to be considered. The committee restricted its considerations to hazardous solid and liquid wastes generated by industry during the processing and synthesizing of materials, omitting hazardous waste materials covered under the Clean Air Act and the Clean Water Act and mine tailings and drainage, stack effluents, slag and ash, nuclear wastes, hospital wastes, municipal refuse and sewage, agricultural wastes, wastes at abandoned waste dumps, and improperly stockpiled material. In Figure 1, the general relationship among pollution control activities for industry is depicted. The shaded portion represents technologies or processes used by industry for manufacturing or for wastewater treatment that can influence hazardous waste management. Usually this influence occurs by process modification, resulting in solid or liquid hazardous wastes that are less in volume or degree of hazard. The committee provided examples of technologies that reduce volume or degree of hazard but did not address this area in detail because of the proprietary or highly specific character of these process modifications. Starting with a material that was generated and defined as a hazardous waste, the committee examined specific technologies for treatment, conversion, or perpetual storage as the primary focus of hazardous waste management.

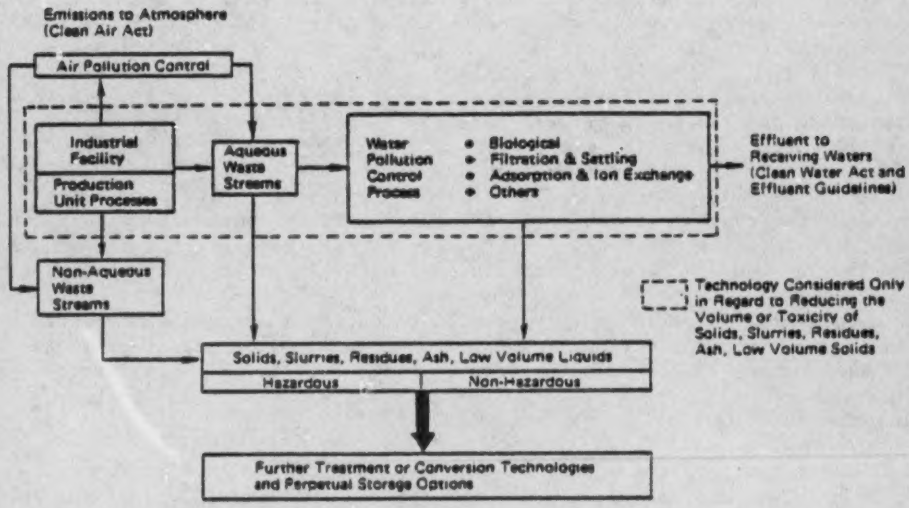
Emissions to Atmosphere (Clean Air Act)
Air Pollution Control
Industrial Facility
Production Unit Processes
Aqueous Waste Streams
Water Pollution Control Process
• Biological
• Filtration & Settling
• Adsorption & Ion Exchange
• Others
Effluent to Receiving Waters (Clean Water Act and Effluent Guidelines)
Non-Aqueous Waste Streams
Technology Considered Only in Regard to Reducing the Volume or Toxicity of Solids, Slurries, Residues, Ash, Low Volume Solids
Solids, Slurries, Residues, Ash, Low Volume Liquids
Hazardous
Non-Hazardous
Further Treatment or Conversion Technologies and Perpetual Storage Options

FIGURE 1 Generation of hazardous industrial wastes.

The committee's discussions of hazardous industrial waste problems and solutions were supplemented by presentations from academic, government, and industry experts involved in areas of hazardous industrial waste management and disposal. On the basis of these discussions and presentations, the committee set the objectives and developed premises and assumptions that provided direction for this report.

The committee concluded early on that public perception, sociopolitical forces, and other non-technical factors are substantial influences on the nationwide management of hazardous wastes. This linkage of technical and non-technical issues was subsequently developed in this report by a description by the committee (as a body of informed citizens in these non-technical areas) of the issues related to public perception and by a substantial description in this introduction of the assumptions, clarification of issues not elaborated, and the framework for organizing the specific technologies that were considered.

The committee recognized that any classification system for wastes, no matter how desirable, is artificial and designed to portray or explain a specific purpose. Such a simple classification system would not be capable of representing or even listing the total spectrum of known hazardous wastes, treatment and disposal technologies, and other chemical, physical, hazard- and cost-related parameters. Instead, the committee considered the wastes mentioned on page 1 and then defined broad-based technologies that might be appropriate for their treatment and disposal. During the committee's study, several waste classification schemes were reviewed; viz., process stream categories in RCRA, risk assessment and degree of hazard classifications being developed by the Office of Technology Assessment (1981), technology and chemical property matrices under study by the Chemical Manufacturers Association. These schemes were designed to serve a specific purpose and solve particular problems for the authors such as enforcement of and compliance with regulations, prioritization of wastes for disposal, research and development funding, and utilization of capital and equipment resources.

The specific premises and assumptions established by the committee are discussed in the following sections. Although each set of premises and assumptions is discussed separately, some overlap was unavoidable.

PUBLIC PERCEPTION

The segment of the public most concerned with hazardous industrial waste problems and solutions consists of those individuals who are or are likely to be directly affected by the problems and solutions. This group includes individuals who live adjacent to an industrial facility or disposal site, individuals who live downwind or downstream of a facility or site and may be affected by discharges from the facility or site, community leaders, and individuals who may benefit from the industry producing the wastes or the availability of the hazardous waste disposal site.

No single technique or method presently available or expected in the near future is a panacea for hazardous industrial waste management problems. Thus, a variety of methods and options must be used to manage these wastes in an environmentally sound manner. The public, however, appears not to appreciate the necessity for multiple approaches and continues to seek a single, simple solution. Unfortunately no such single solution exists. In addition, the public's lack of understanding of the issues makes it impossible to distinguish among clearly superior and inferior solutions to hazardous waste management problems. This lack of understanding about how hazardous wastes are generated and managed can have a number of adverse effects: Stifling of innovation, seeking of simplistic solutions, stockpiling of hazardous wastes, intervening by government, utilizing "quick fixes" (disposal by the most expedient available technology) and illegal methods.

The committee believes that overcoming this lack of understanding is an important hazardous waste management need. Although this issue was outside the scope of the committee's study, the committee emphasizes that the success of any technical, scientific, or research solutions it recommends is contingent on a change in this sociological situation. During its deliberations, the committee assumed that progress will be made and that the public will develop a more rational view of hazardous waste management.

GENERAL SOLUTIONS

A variety of approaches to the management of hazardous industrial wastes are outlined in Subtitle C of the 1976 Resource Conservation and Recovery Act (RCRA). These techniques as well as several other important methods for hazardous industrial waste management were considered by the committee (Figure 2). There are basically three general options: elimination or reuse of the hazardous waste, conversion of the hazardous waste into nonhazardous or less hazardous material, and perpetual storage. These general options differ substantially in terms of philosophy, time-frame, technique, and economics. At present, perpetual storage methods are the most prevalent and, hence, are the focus of attention for both regulatory and industrial personnel.

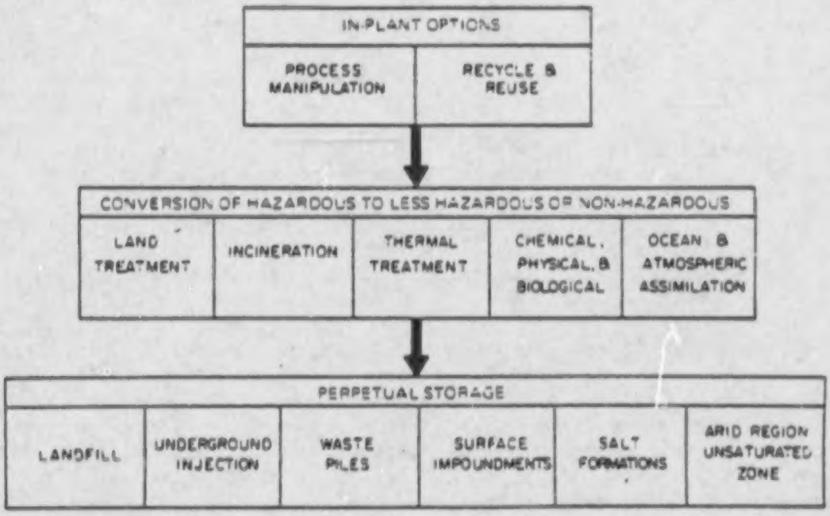
IN-PLANT OPTIONS
PROCESS MANIPULATION
RECYCLE & REUSE
CONVERSION OF HAZARDOUS TO LESS HAZARDOUS OR NON-HAZARDOUS
LAND TREATMENT
INCINERATION
THERMAL TREATMENT
CHEMICAL, PHYSICAL, & BIOLOGICAL
OCEAN & ATMOSPHERIC ASSIMILATION
PERPETUAL STORAGE
LANDFILL
UNDERGROUND INJECTION
WASTE PILES
SURFACE IMPOUNDMENTS
SALT FORMATIONS
ARID REGION UNSATURATED ZONE

FIGURE 2 Hazardous waste management.

Optimum, successive utilization of the three general options would result in a decreasing amount of hazardous wastes as treatment proceeds in the direction of the arrows in Figure 2. Only small volumes of the more inert materials should be considered for perpetual storage. The hierarchy identified in Figure 2 should be followed in the management of hazardous wastes: (1) in-plant options should be used to reduce the volume and toxicity of generated hazardous wastes, (2) wastes that are generated should be converted to less hazardous forms and should be reduced in volume, and (3) remaining residues and wastes that are hazardous should be stored in a manner that minimizes risks to the environment and the public.

Identification and understanding of this hierarchy permits rational decisions to be made, best risk solutions to be identified, and better public understanding of the issues. The management approaches outlined in Figure 2 also stress that no one approach is sufficient to solve hazardous industrial waste management problems. Further, the concepts identified emphasize prevention and reduction rather than treatment and storage and aim to reduce the risk to the environment and public. Thus, the emphasis is on positive rather than negative management options.

IN-PLANT OPTIONS

In-plant options are probably the most effective and economical means of managing hazardous wastes. These options represent approaches that generally minimize impact on public health and the environment. Minimizing or eliminating waste production is substituted for end-of-pipe management. These options include:

1. Process modifications to eliminate or reduce the volume of specific hazardous wastes. These involve altering the chemistry or the chemical engineering operations to achieve the desired waste elimination or reduction within the constraint of acceptable and economical product manufacturing.

2. Recycle and reuse processes to prevent materials from being discharged from the plant as waste. Use of these techniques recognizes that the hazardous components of wastes may be usable reactant materials in other production processes.

As the costs of waste treatment and disposal increase, cost-reduction achieved through recovery of chemicals from the waste stream prior to disposal will become more important. The value of reclaimed chemicals plus the savings in not having to dispose of them could match or exceed the original disposal costs. An example may be cited from the leather and tanning industry: Chromium removal from wastes has been well demonstrated, but the net gains from recovery and sale on the commercial chromium market have been marginal. However, the substantially increased costs of secure landfill or even the lower cost of land treatment under pending RCRA regulations indicate that it will probably become significantly more cost-effective to remove the chromium from such wastes (Overcash 1980).

Because of the largely proprietary nature of the technologies, the committee decided not to undertake an extensive technical review of or make recommendations on process modification and recycle and reuse. However, the committee strongly recommends a major commitment, both philosophically and in funding, to approaches that prevent or eliminate hazardous materials from being discharged as wastes.

CONVERSION TECHNOLOGIES

Technologies that convert hazardous wastes into less hazardous or nonhazardous wastes fall into two classes:

1. Incineration, thermal treatment, chemical, physical, and biological processes, all of which convert wastes from a hazardous to a less hazardous or nonhazardous state. These processes produce a residue (either as a by-product or as a waste stream) that may or may not have an adverse environmental impact and that must be discharged to the environment or stored in an environmentally sound manner.

2. Land treatment that converts the hazardous wastes but also provides the ultimate disposal site.

Combinations of these conversion processes can be used to manage hazardous industrial wastes. These technologies are consistent with the philosophy of environmental regulations (i.e., to render hazardous industrial wastes nonhazardous).

PERPETUAL STORAGE

Perpetual storage is the most prevalent existing hazardous waste management practice. Each perpetual storage technology attempts to place the waste material in a highly condensed or concentrated configuration in which the hazardous constituents do not move. Generally little or no conversion from a hazardous state occurs, and, hence, care, monitoring, and migration prevention are required for an indefinite period. The committee decided that at least 500 years was realistic as a period of concern for hazardous wastes in landfills and perpetual storage options. Regulations under RCRA establishing the period of concern for landfills as 30 years were considered by the committee to be unrealistic. Careful attention to design for containment over such short control periods does not eliminate the probability of containment system failure after 30 years. Instead, the likelihood of adverse impacts and the realistic costs of perpetual care by compliance to the letter of the law are only masked.

The storage technologies clearly involve a long-term obligation because with time, particularly at a closed site, most of the changes that can occur are adverse (e.g., eventual penetration of a surface cover, gas diffusion and leakage to the atmosphere, and leakage of mobile constituents to groundwater). As an illustration, experience with some nuclear waste repositories (not specifically discussed in this report) provides an example of unsuccessful results with long-term storage. Despite the best intentions these have a proven record of leakage to the environment during a relatively short period amounting to a small fraction of the 500-year lifetime deemed necessary by the committee to be a realistic period for perpetual storage.

The central questions to be addressed with regard to perpetual storage concern the technology and the procedures for implementation. The question still not being widely addressed is how to accommodate these sites over their probable, greater than 500-year life. It is indeed possible that hazardous waste problems and consequences are merely being postponed and will have to be dealt with by future generations. If this could be argued convincingly (or even addressed), then a realistic consideration of the direction for hazardous waste management could be undertaken. The committee believes that this question, although it is not within the scope of this study, should be evaluated critically before public acceptance of perpetual storage of hazardous industrial waste can be expected. The committee concludes that it is desirable to select the perpetual storage alternatives that are the most stable and provide the maximum isolation from the rest of the environment.

TIME-FRAMES

The options noted in Figure 2 have different liabilities and time-frames associated with them. The in-plant options relate to very short time-frames (hours to days), with effects limited to those of short duration (i.e., those resulting from extreme operating conditions). They are subject to normal community acceptance and Occupational Safety and Health Administration considerations.

The environmental and societal effects of conversion technologies in Figure 2 involve an expanded time-frame (minutes to years). Short- and long-term effects on air and groundwater quality must be addressed. Dispersion occurs in a current time-frame and is taken into account as part of the design and monitoring approach. Its effects must not violate acceptable air, drinking water, and land use standards. Thus, the effects of these technologies are essentially short term.

For the storage category in Figure 2, the time-frame is much longer (decades to centuries). The liability is therefore likely to be shifted from those who generate or store the waste (the present generation) to future generations. These technologies could provide a potentially adverse environmental legacy.

For technologies in which the character of the hazardous waste remains for a long period (30 years) there is increasing likelihood of non-containment. Reliable containment for very long periods (1000 years) is an advantage when the true costs of monitoring and remedial action are included with the placement of a waste in such facilities. The shorter the lifetime of the hazardous waste technology, the better the control and the lower the dispersion potential generally associated with that technology. Longer storage periods create much larger unknowns and much less opportunity for management and control.

ZERO RISK AND ZERO DISCHARGE

The concepts of zero risk and zero discharge are interwoven explicitly and implicitly into most environmental discussions. That one cannot achieve zero risk or zero discharge is clear to the committee and has been basic to its discussions and recommendations. The laws of thermodynamics and probability assure that zero risk or zero discharge cannot be achieved. Although the committee did not attempt to assign quantitative values to acceptable risk, it recognized the critical need to develop methods of risk assessment and put them into practice.

It has been argued that zero risk and zero discharge serve as valuable goals for society even though they may be unachievable. Regulations have often accepted that philosophy. However, this impossible target has become a liability in achieving real progress. Goals of zero risk and zero discharge initially were effective in overcoming inertia but have since become an impediment to progress in hazardous waste management. Thus, the committee rejected the criteria of zero risk or zero discharge in evaluating the acceptability of technologies for hazardous waste management. To the extent that the public maintains a belief in zero risk and zero discharge, there will be major difficulties in managing hazardous wastes. The committee concluded that the major part of all risk and discharge must be assumed in a present day time-frame and not deferred to future generations.

In the area of risk acceptance, the committee believes that risk quantification is urgently needed. Most activities of daily life pose some risk of injury, sickness, or death. Similarly, there is some risk associated with hazardous waste management, and some alternatives have higher risks than others. It is critical that some level of risk assessment be put into practical use. This could occur through a combination of scientific and judicial review and opinion, regulatory practice, professional society standards, and public awareness and acceptance.

The Office of Technology Assessment (1981) approached this problem in terms of a degree-of-hazard concept applied to regulatory policies. This is a limited approach and focuses on criteria for defining a hazard. The broad and more important problem is the level of acceptable risk. That some technologies, when applied to hazardous industrial wastes, will have higher risk factors than other technologies must be considered in decisions regarding such wastes (including their management and/or ultimate disposal).

GLOBAL ASSIMILATIVE CAPACITY

As discussions in the committee proceeded, it became clear that the global environment (atmosphere, sea and estuarine systems, and terrestrial mass) should continue to constitute a source of usable, natural treatment processes. The committee's decision to consider all phases of the total earth environment was based, however, on the assumption that treatment, or dilution accompanied by physical or chemical action, could occur without serious or irreversible damage to the environment. The burden of proof as to the reasonable absence of potential environmental damage caused by such use should rest primarily with the waste disposer rather than with private environmental organizations or government agencies.

The critical requirement is that treatment (specifically, conversion to nonhazardous material) actually occurs. For example, the use of the upper two meters of soil to decompose and fix constituents of hazardous waste is a method that uses the terrestrial environment to accomplish treatment. Thus, land treatment was recognized by the committee as a proper use of the assimilative capacity of nature.

The committee also recognized that the atmosphere and ocean have an assimilative capacity for hazardous waste, although a policy of restricted use of the ocean assimilative capacity for hazardous waste is in direct conflict with some international accords. The scientific community is in disagreement over the advisability of using ocean assimilation (Goldberg 1981, Kamlet 1981) even though the assimilative capacity is acknowledged to exist. The committee recognized this conflict but concluded that further research and pragmatic approaches to assimilation by the global environment might be valuable in dealing with the international problem of hazardous wastes.

Research on the utilization of the treatment and assimilative capacity of all phases of the global environment was considered justified by the committee. Several statements summarize the committee rationale in this area:

1. The use of selected parts of the total earth environment has already been successful; thus, the existence of the earth's assimilative capacity has been demonstrated.

2. Within restraints that avoid environmental degradation, the use of the environmental assimilative capacity can be a continuing process. The use of such self-renewing techniques assures little or no burden on future generations, but only if the extent of the assimilative capacity is known. The challenge is to quantify the treatment potentials.

3. The more sensitive parts of the global environment have lower assimilative capacities, not zero tolerances. Economics will dictate whether a specific phase of the environment would actually be used, assuming that there are adequate controls over such use.

In general, the committee believes that with adequate testing, monitoring, and regulation, the successful utilization of the global environmental assimilative capacity, including that of the soil, atmosphere, and the ocean, could be a viable and justified technological alternative in the management of industrial hazardous waste.

ECONOMICS

The committee recognized that economics underlie almost all of the decision-making in selecting management options for hazardous wastes. Several facets of the economic picture appeared universal.

First, the use of all technologies, regardless of the present degree of development, will be improved if there are cost reductions. Those options that have the lowest costs and produce the best control will be more widely utilized. In many cases, the only existing economic analyses for newer technologies derive from small-scale, laboratory-level applications. Full-scale research or usage should result in a better knowledge of actual costs. The lack of specific recommendations by the committee regarding work toward lower costs should be construed only as recognition that such a need exists almost universally among hazardous waste management technologies.

Second, the committee determined that obtaining reliable cost estimates of ongoing hazardous waste management was an important need. It is essential to know what typical investment and operating costs are at full-scale industrial facilities. This area is cloudy because both *a priori* calculations and commercial sales information are being utilized simultaneously in comparisons of alternatives. More actual systems evaluations are a universal need in the management of hazardous wastes.

Third, the committee concluded that cost comparisons must be made on an "environmentally equivalent" basis. Comparisons between technologies that detoxify wastes and those that store material for a 30-year period only confuse short- and long-term economics. From the standpoint of technology assessment, all alternatives should be evaluated using the same ground rules. The comparison should include costs from the time of hazardous waste generation until the hazardous characteristics have permanently disappeared or can be assumed immobilized even over very long periods.

This type of environmentally equivalent economic determination is certainly not being made for one notable technology--hazardous waste landfills. The present costs of operating these facilities do not include realistic long-term costs. There is an obvious preference for turning responsibility over to some level of government for long-term costs and liabilities. Thus, incomplete landfill costs are currently compared with those for a chemical detoxification facility or a land treatment system in which the hazardous wastes are rendered nonhazardous. Such comparisons are not environmentally equivalent and do not provide a true measure of societal costs.

The committee did not attempt to list in-place and operational costs for each environmentally equivalent technology. This, however, should not be construed to mean that economics is not an important factor.

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CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Hazardous industrial wastes exist and must be dealt with in the context of present day society. Fewer hazardous wastes (in volume and degree of hazard) will be generated in the future as process changes and in-plant modifications are made. However, complete solutions for hazardous wastes will still require treatment, conversion, and perpetual storage of the lesser amounts of materials that cannot be otherwise eliminated or recycled.

The disposal of hazardous wastes is a national problem, one that affects the national economy and the national future. Academia, government, and industry should all play a role in meeting the research and development needs for hazardous waste management.

There currently exists some technology or combination of technologies capable of dealing with every hazardous industrial waste in a manner that eliminates the need for perpetual storage. At least in principle, inorganic components can be separated and reused and organic compounds can be destroyed. In general, however, the present state of development of many of the required technologies is such that they are not commercially available at a cost that makes their use feasible.

An objective of the sponsors was to have recommendations for new technological approaches to hazardous waste management. However, the committee found no major new and cost-effective approach. Since no single, existing technique is likely to be developed into a panacea, funding should be continued mainly to improve existing technologies, particularly for making methods more reliable in design and operation and more cost-effective for specific waste streams. Further, current technologies involving perpetual storage must continue to be used, at least for the immediate future, and the problems they cause must be faced.

All hazardous industrial waste disposal technologies involve some risk since zero risk and zero discharge are not achievable. It is essential that alternative technologies be subjected to a quantitative risk assessment that takes broad account of societal concerns. The committee concluded that the concept of "environmental equivalence" should be used in these comparisons. Such assessments must be acceptable to the public as well as to the scientists and engineers who are knowledgeable in the field.

All hazardous industrial waste disposal technologies need complete economic evaluation, so that comparisons can be made of their actual costs. Economic evaluations must include the long-term (sometimes in excess of 500 years) facets of certain hazardous waste management alternatives.

To a large extent, specific disposal technologies are particularly suited to specific hazardous industrial wastes. In general, therefore, wastes should not be mixed together or diluted without reason, and, in addition, the choice of disposal technologies should be based on specific waste disposal needs.

The disposal of hazardous industrial wastes should be approached in a hierarchical fashion, first attempting to minimize waste production through process modification and recycling, next seeking to convert the waste to nonhazardous or less hazardous forms, and finally making use of perpetual storage.

The committee recommends that:

1. A centralized, accessible, and periodically updated economic evaluation of each hazardous industrial waste disposal technology be developed, together with an assessment of each technology's availability and state of commercial development.

2. A methodology for hazard and risk assessment of hazardous industrial waste disposal technologies and transport be developed and applied. Both public and environmental risks should be covered in a manner that allows comparison with existing risks that are acceptable to society.

3. An educational program be established to provide the public and industry with soundly based information on the options and risks associated with the disposal of hazardous industrial wastes.

4. A methodology for dealing with the problems of siting of hazardous waste treatment and disposal facilities be developed, with particular attention to regional treatment facilities.

5. Resource recovery or waste elimination receive first emphasis in all considerations of hazardous industrial waste management.

6. Manufacturers of products plan ahead for the ultimate treatment and disposal of these products and the by-products of their manufacture so as to minimize technical problems and adverse environmental consequences.

INSTITUTIONAL CONSIDERATIONS

Progress toward the satisfactory management of hazardous industrial waste is inhibited by nontechnical as well as by technical shortcomings.

These factors are basically institutional in nature, and they are so fundamentally involved in any discussion of waste disposal technologies and technology applications that their consideration cannot be avoided.

Public attitudes toward hazardous industrial wastes and their disposal reflect a number of misconceptions. Among these are beliefs that hazardous waste generation can be eliminated, that waste discharges can be avoided, that waste disposal can be made risk free, and that hazardous waste disposal technologies are equally risky to the local environment and health. Satisfactory management of hazardous industrial wastes depends on an informed and enlightened public.

Long-term reliability and consistency in the management of hazardous industrial waste disposal operations must not be hampered by changes in regulatory philosophy, hasty legislative and regulatory actions in response to problem situations, inconsistent enforcement, and technically unachievable regulations that discourage all but minimum compliance with current requirements. Satisfactory management of hazardous industrial wastes depends on establishing goals for the long term and adopting a consistent, realistic approach to achieving them. The public deserves nothing less.

Local jurisdictions have generally been unwilling to act jointly to bring about the establishment of centralized waste treatment facilities, where larger scale operations would provide efficiencies in cost, environmental control, and resource conservation and recovery. A reluctance to deal with the problems of hazardous industrial waste management on the part of a single jurisdiction often rules out action on the part of others. Satisfactory hazardous industrial waste management depends on a commonality of effort to resolve a national problem.

The committee recommends that:

1. A program of public education, in the broadest sense, be initiated to inform and to provide a positive view of the necessity of overall management of hazardous industrial wastes, the nature of the alternative technologies, and the success of disposal operations that could serve as models for future developments.

2. Review and revision of existing legislation be considered to assure its consistency and technical validity, particularly with regard to the long term and the enforcement of regulations, and to establish reasons for public confidence in the goals set for the management of hazardous industrial wastes.

3. The federal government encourage the formation of centralized facilities for the treatment of hazardous industrial wastes by arranging to coordinate such activities, by seeking the removal of legal barriers at the national, state, and local levels, and by providing assurance to the public that concerns for health, safety, and the environment will not be neglected.

CHEMICAL AND PHYSICAL TECHNIQUES

Chemical and physical techniques, described classically as unit processes and unit operations, consist primarily of conversion (degradation) processes such as neutralization, oxidation, reduction, and precipitation and separation (concentration) processes such as distillation, filtration, and adsorption. A very large number of these techniques are available, and they are used widely in dealing with hazardous industrial wastes, both in manufacturing and treatment operations. Their application may come before, after, or as part of another treatment method or they may themselves be sufficient. Known wastes consisting of one or a few hazardous components can often be disposed of effectively using these techniques, but they are less suitable for wastes of mixed or variable composition. They have the advantage of being carried out under controlled conditions, and this allows risks to be minimized.

Although, in principle, chemical and physical techniques could be developed to dispose of any hazardous industrial waste, it is unlikely that this would be a generally cost-effective approach. However, even in current applications, improvements could be made if more fundamental data on the thermodynamic, kinetic, and transport properties of the waste materials were available. Particularly with organic materials, general property correlations would help in the optimization of separation processes and thus facilitate recovery of valuable compounds. Specific chemical procedures such as the reductive dechlorination of chlorine-containing organics, should be considered.

The committee recommends that:

1. Experimental determination of physical properties of various hazardous waste species and mixtures be continued. Additional research on predictive and correlational methods is warranted.

2. Processes for metal removal and recovery from hazardous industrial waste streams be investigated to improve the options for pre-treatment of wastes to be disposed of by biological techniques, land treatment, and incineration. Ion exchange, adsorption, and liquid extraction methods are likely candidates for development.

3. Separation processes based on supercritical fluids, liquid membranes, and foam fractionation (especially microgas dispersions) be developed further. Separation of organics from largely aqueous waste streams would allow the use of incineration.

4. Research be directed toward a low-cost process for removing water from slimes and sludges, so that the chosen disposal method (perhaps by land treatment, permanent storage, or landfilling) can be simplified.

BIOLOGICAL TECHNIQUES

Biological waste treatment processes have been widely used for the treatment of both municipal and certain industrial wastes, and the technology is well established in these areas. Although there can be applications to hazardous industrial wastes, biological treatment processes will generally constitute only one step in a hazardous waste treatment and disposal system. There are a large number of biological treatment processes that use indigenous or adapted microbial organisms for the removal or detoxification of hazardous industrial wastes. In these systems, waste constituents can also be removed by air stripping, volatilization, and adsorption on solids. As with chemical and physical processes, biological processes are carried out under relatively well-controlled conditions of residence time, temperature, and pH.

Biological waste treatment processes can be adapted to liquids, slurries, and solid organic wastes. Toxic constituents can inhibit microbial growth in such processes, and there can be difficulties in maintaining a sufficiently diverse population of microorganisms to metabolize the waste materials at desired rates. Detailed information is needed on the ability of biological treatment processes to detoxify specific hazardous industrial wastes using both indigenous and genetically manipulated organisms.

The committee recommends that:

1. The mechanisms of hazardous industrial waste removal be studied in one or more existing or clearly usable biological treatment processes so that better utilization of this alternative can be developed and the transfer of toxic pollutants from one medium to another can be minimized.

2. Analytical measurement techniques, beyond fish bioassay methods, be developed to provide measures of detoxification when biological treatment processes are used.

3. Genetic engineering of microorganisms be investigated as a means of improving detoxification of hazardous industrial wastes. Competition from naturally occurring organisms should be investigated.

4. Thermophilic biological techniques be studied to determine if improved detoxification and removal can be achieved economically with these processes.

LAND TREATMENT

Land treatment makes use of the assimilative capacity of the environment in the disposal of hazardous industrial wastes, taking advantage of natural biodegradation processes as well as environmental chemistry. Organic materials are metabolically degraded, and both organic and inorganic materials are subject to oxidation or reduction and to immobilization by adsorption and reaction in the soil. Land treatment has been applied successfully in the disposal of municipal and non-hazardous industrial wastes as well as in the treatment of hazardous industrial wastes.

In principle, land treatment is capable of handling all hazardous industrial wastes. In practice, the capacity of the land for specific waste components may be limited by the cost of land areas to match assimilative capacity to waste generation. Therefore, pretreatment of the waste may be required to achieve reasonable costs. Pretreatment may also be considered as a means of extending the life of land treatment systems receiving constituents that accumulate. The behavior of the constituents in a land treatment system can affect air and water receiver systems, and therefore, designs for land treatment must take into account both short-term and long-term environmental effects.

The committee recommends that:

1. The data base for the design of a land treatment system be expanded, with emphasis on transferable laboratory- or pilot-scale information and refinement of this information in selected field-scale systems.

2. The economics of full-scale hazardous waste land treatment systems be further documented.

3. Process modification and pretreatment be investigated as adjuncts to land treatment.

4. An effort be made to make industry aware that land treatment has technical and economic potential.

OCEAN ASSIMILATION

Ocean assimilation, like land treatment, makes use of the assimilative capacity of the environment for the disposal of hazardous industrial wastes. Many of the same assimilative processes operate to degrade and detoxify wastes, but here particular attention must be paid to impacts on marine life and the overall ecological system because of the relatively rapid dispersion which occurs.

Indiscriminate ocean dumping of waste materials has led to banning any form of ocean disposal. This, however, should not preclude investigations into the use of the oceans for hazardous industrial waste disposal under strictly controlled conditions; the oceans, which occupy some 70 percent of the earth's area, may indeed provide a valuable self-renewing resource. Except in connection with past problems caused by specific wastes, often in specific locations, relatively little is known about the degradation of wastes in the marine environment. High dilution is likely to make such studies difficult, but it may well facilitate the degradative processes by minimizing the impact on the marine environment. As with land treatment, pretreatment of wastes to remove specific components may be required.

The committee recommends that:

1. The effects of selected past ocean disposal (dumping) of wastes be determined to assess the possible consequences of ocean disposal of hazardous industrial wastes.
2. The dispersal and degradation rates of hazardous industrial waste constituents in the marine environment be studied.
3. Systems be developed to monitor ocean disposal processes and their impact on marine ecology.
4. Modeling of ocean assimilation be studied.

INCINERATION

Incineration is a useful technique for the conversion of hazardous industrial wastes to less or non-hazardous materials; it is applicable to all organic materials provided the necessary temperatures and residence times can be achieved. It finds widespread use in a large variety of installations, among them boilers, kilns, furnaces of special design, open pits, rotary hearths, and vertical shaft incinerators. These can be powered by both hydrocarbon and refuse-derived fuels. In some cases, energy can be recovered with the co-generation of heat or electricity.

For many organic materials, incineration affords the most complete means of waste management available via current technology, but emission controls are frequently required to prevent air pollution. The inorganic components present in waste produce slag and ash that must be disposed of and, on occasion, toxic volatile materials that must be collected. Shipboard and ocean platform incinerators avoid some of the problems associated with emissions but entail significant transport problems for all but hazardous industrial waste generators located near ocean coasts. With more precise information on the temperature and time requirements and design parameters for specific classes of wastes, a more extensive use of incineration would become feasible, particularly if processes were to be developed for existing industrial boiler systems.

The committee recommends that:

1. The rates and products of combustion of hazardous industrial wastes be determined as a function of waste type, temperature, and residence time to assess the feasibility of widespread use of existing systems for incineration.

2. Fuel additives and improved scrubbing systems be studied and developed for improved control of incinerator emissions.

3. Operational studies of offshore platform incineration be carried out.

4. Policy and economic studies of ocean shipboard incineration be undertaken.

THERMAL METHODS

Thermal methods utilize heat rather than the open flame of incineration to decompose and detoxify hazardous industrial wastes by oxidation and pyrolysis. Examples include catalytic and reactive fluidized bed systems, molten salt reactors, plasma arcs and torches, microwave systems, and pyrolytic processes. Of these, only pyrolytic processes have been widely used in industry. Thermal methods are generally applicable to hazardous industrial wastes, but they are usually more costly than incineration and are more suitable for disposing of specific wastes for which conventional incineration is not readily adapted.

Although higher heat transfer coefficients may result in lower temperature requirements for destruction than with incineration, several of the thermal methods, particularly those involving microwaves and plasmas, require high energy inputs that make them less economically attractive. On the other hand, fluidized bed media can be selected to react with inorganic components such as chlorides, thus reducing or eliminating problems with emissions. In addition, a number of thermal methods are suited to operation on a scale smaller than that of conventional incinerators, making portability of the treatment facility possible. Overall, thermal methods offer considerable promise for disposing of specific, difficult wastes.

The committee recommends that:

1. Operating parameters for the destruction of specific hazardous industrial wastes in molten salt, fluidized bed, wet air oxidation, and pyrolysis systems be determined.

2. The selection of materials of construction for molten salt, fluidized bed, wet air oxidation, and pyrolysis systems be studied to improve corrosion resistance and operating life.

3. Plasma and microwave systems be investigated for destruction and detoxification of hazardous industrial wastes that are difficult to handle.

4. Pyrolysis methods be developed for organic wastes as a means of detoxification and conversion to usable forms, such as fuels.

5. Evaluation of co-catalyst systems for use in conjunction with specific technologies (i.e, wet air oxidation, fluidized beds, and specific waste streams) be investigated.

LANDFILLS

Landfill is currently the major method used for the disposal of hazardous industrial wastes. In the past, landfills were indeed "toxic dumps," but today, since they are regulated, they are better described as "secure landfills," intended basically as permanent storage that provides "perpetual" isolation from the environment. To assure perpetual isolation, however, requires perpetual care at a cost that is generally being ignored.

For the immediate future, landfills represent a necessary technology for disposal of hazardous industrial wastes; but, for the long term, they may not remain the major alternative for perpetual storage. In the future, only non-reducible inorganic residues might be considered for any perpetual storage alternative. The contents of a landfill are recoverable, at least in principle, to the extent that the landfill is properly managed and controlled. There is, however, a good deal that is not known about long-term landfill behavior, and policies for long-term care and management of landfills have yet to be established.

The committee recommends that:

1. The use of landfills be minimized to prevent the likely migration of constituents of the waste into groundwater.
2. Systems be developed for improved sampling and monitoring of hazardous industrial wastes in soils and leachates.
3. Modeling of migration from landfills be studied.
4. Liner and cover materials be evaluated for long-term performance.
5. Materials and methods of encapsulation and solidification be investigated, with particular attention to long-term behavior.

PERMANENT STORAGE OR DISPOSAL

Permanent storage or disposal involves deep well injection or underground burial, with or without barriers to migration and with or without immobilization by solidification or fixation. Currently, deep well injection is practiced fairly extensively with liquids, but, like landfilling, the practice has been declining. With disposal in mines and salt domes, wastes are, in principle, recoverable. However, these techniques approach disposal with the expectation that the wastes will be so isolated by distance or by degradation that they will never again encounter the biosphere.

A variety of sites are available for this method of disposal, among them solution cavities, worked-out and abandoned mines, and geological basins. Such locations, however, have not been adequately inventoried and characterized, and there is not much known about the degradation and reaction rates of wastes and their possible migration in many potentially usable regions.

The committee recommends that:

1. An inventory of possible sites for permanent disposal be generated, with information on site characteristics and potential problems in handling the disposal of solids, liquids, and slurries.

2. A more concerted and directed research effort be made to assess the feasibility of using as burial sites for hazardous wastes the thick unsaturated zones (water free) underlying much of the western United States. The utility of these zones may be pivotal in providing a reasonable solution to the whole problem of disposal of hazardous wastes.

3. Chemical degradation and reactivity studies of liquid hazardous industrial wastes in the injection environment be carried out, taking account of the temperatures, local brine chemistry, pressure, and fluid migration rates.

4. The long-term stability of containers and encapsulated or solidified materials in the disposal environment be investigated.

5. The long-term stability and performance of various kinds of barriers between wastes and the local environment be studied.

United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Cincinnati OH 45268

Research and Development

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EPA

Project Summary

Emerging Technologies for the Control of Hazardous Wastes

Barbara H. Edwards, John N. Paullin, and Kathleen Coghlan-Jordan

Investigations were conducted of new and emerging technologies for the disposal of hazardous wastes. These methods involve new technologies or a recent variation on an established one. In addition, a survey was made of potential users of hazardous waste information. The need for a data base for emerging hazardous waste technologies and/or a newsletter was evaluated. Information on the emerging technologies was acquired by computer [illegible] search, library searching, and personal contacts. The emerging technologies discussed include molten salt combustion, fluidized bed incineration, high energy electron treatment of trace organic compounds in aqueous solution, the catalyzed wet oxidation of toxic chemicals, dehalogenation of compounds by treatment with ultraviolet (UV) light and hydrogen, UV/chlorinolysis of organics in aqueous solution, the catalytic hydrogenation-dechlorination of polychlorinated biphenyls (PCBs), and ultraviolet/ozone destruction. Theory, specific wastes treated, and economics are discussed.

The major technologies investigated in detail were molten salt combustion, fluidized bed incineration, and ultraviolet/ozone destruction.

Among the wastes treated by emerging technologies are PCBs, various Dioxins, pesticides and herbicides, chemical warfare agents, explosives and propellants, nitrobenzene, and hydrazine plus its derivatives.

This document encompasses a target audience ranging from laymen to natural scientists. The information presented here was derived solely for application to hazardous wastes. Readers requiring more specific information about theory and the economics of start-up plus operating and maintenance costs for technologies that may by applied to a specific hazardous waste not discussed in this report are referred to the literature cited in this report and to documents about state-of-the-art situations for a particular technology.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The material for the identification and evaluation of these technologies has been gathered through an intensive literature survey conducted over the course of a year. Although extensive use has been made of manual and computerized data bases, it was also necessary to monitor the recent literature and forthcoming conferences and symposia abstracts access material not yet in the literature. Personal communications were also used in the survey.

Major hazardous waste generators in the United States were surveyed for their hazardous waste information needs. Fifty-three of the 72 companies surveyed were identified by a Waste Disposal Site Survey Report from the House of Representatives Committee on Interstate and Foreign Commerce

(Subcommittee on Oversight and Investigations) as the largest domestic generators of hazardous waste.

Conclusions

Molten salt combustion

Molten salt technology has existed for many years, but it has not been used for the disposal of hazardous wastes until recently. In the process, hazardous material is combusted at temperatures below its normal ignition point, either beneath or on the surface of a pool of molten salt. Individual alkali carbonate salts such as sodium carbonate, or mixtures of these salts, are usually used as the melt, but other salts can be employed based on the characteristics of the waste. Containers for the molten salts are made of ceramics, alumina, stainless steel, or iron. Ideally, during the molten salt process, organic substances are totally oxidized to carbon dioxide and water. Generally, the salt bath is stable, nonvolatile, nontoxic, and may be recycled for further use until the bath is no longer viable. The technology has progressed from bench-scale through the pilot plant stage to the construction of a demonstration-sized coal gasification unit. Portable units mounted on trucks have been tested.

Some of the advantages of molten salt combustion are as follows:

- Combustion is nearly complete.
- Non-polluting off-gases are generally emitted.
- Operating temperatures are lower than in normal incineration; thus, they are fuel efficient.
- The system is amenable to recycling generated heat.
- A wide variety of wastes can be combusted.
- Bulky wastes can be combusted after recycling.
- Many wastes can be combusted in compliance with EPA regulations.

Some of the problems of molten salt combustion are as follows:

- Particulate emissions from some wastes are high.
- The technology is not readily adaptable to aqueous wastes.
- Eventually waste salt and ash must be disposed of or the fluidity of the melt will be destroyed.
- A hazardous waste with greater than 20% ash cannot be combusted.
- Detailed economic information for a demonstration-sized system is not currently available for many wastes (1980).

Fluidized bed incineration

Fluidized bed systems have had many industrial uses since the technology was proposed by C.E. Robinson about a century ago, yet fluidized bed incineration of hazardous wastes is a relatively new technique. A hot fluidized bed is ideal for combustion. Air passage through the bed produces strong agitation of the bed particles, which promotes rapid and relatively uniform mixing of carbonaceous materials. The bed mass is large in relation to the injected waste, and bed temperatures, which usually range from 750°-1000°C, are usually uniform. Bed materials have included sand, sand mixtures, dolomite, and alumina.

Some advantages of fluidized bed incineration are as follows:

- The combustor design is simple and does not require moving parts after the initial feeding of fuel and waste.
- Fluidized bed incineration has a high combustion efficiency.
- Designs are more compact due to high volumetric rates.
- Comparatively low gas temperatures and excess air requirements minimize the formation of nitric oxide.
- In some cases, the bed itself neutralizes some of the hazardous products of combustion.
- A vertical induced draft incinerator was converted into a fluidized bed.
- The bed mass provides a large surface area for reaction.
- Temperatures throughout the bed are relatively uniform.
- Fluidized beds are able to process aqueous waste slurries.
- If the waste contains sufficient calorific value, the use of auxiliary fuel is unnecessary; moreover, the excess heat may be recycled in some cases.
- The bed can function as a heat sink; start-up after weekends may require little or no pre-heat time.

Disadvantages of fluidized bed combustion are as follows:

- Bed diameters and height are limited by design technology.
- Ash removal presents a potential problem.
- Systems requiring low temperatures may have carbon build-up in the bed due to increased residence time.
- Certain organic wastes will cause the bed to agglomerate.
- Particulate emissions can be a major problem.

UV/ozone destruction

Ozone treatment is an established technology for the treatment of some hazardous wastes; the combination of UV light and ozonation recently has been found to be a more effective process for destroying hazardous waste than the use of ozonation alone. The addition of UV light to the ozonation process has greatly expanded the number of compounds that can be destroyed. PCBs are among the halogenated compounds destroyed. Compounds with shielded multi-bonded carbon atoms, sulfur compounds, and phosphorous compounds are less susceptible to UV/ozonation. Dioxins, nitrobenzene, and hydrazines have been destroyed by UV/ozonation.

Some advantages of UV/ozonation are as follows:

- Aqueous or gaseous waste streams can be treated.
- Capitol and operating costs are not excessive.
- Chemical carcinogens and mutagens can be treated.
- The system is readily adaptable to on-site treatment of the hazardous waste.
- It can be used as a final treatment to supplement partial treatment systems.
- It can be used as a preliminary treatment for certain hazardous wastes.
- It can be used to meet effluent discharge standards.
- Modern systems are usually automated, thereby reducing labor requirements.

Some disadvantages of UV/ozonation are as follows:

- Ozone is a non-selective oxidant; therefore, the waste stream should contain primarily the waste of interest.
- UV/ozone systems are generally restricted to 1% or lower levels of hazardous compounds. Frequently, hazardous substances are treated at ppm levels.
- Ozone decreases rapidly with increasing temperature; therefore excess heat must be rapidly removed.

Results of hazardous waste information survey.

Fifty-three major hazardous waste generators were surveyed for their hazardous waste information needs. Major information needs are:

- new technologies for hazardous waste disposal,
- state-of-the-art methods for hazardous waste disposal,
- best technologies available for destruction of specific wastes plus costs,
- updated federal and state regulations for waste generation, transportation, storage, and destruction of landfills,
- techniques to identify mixed waste streams,
- toxicity data on specific hazardous wastes,
- location of approved hazardous waste disposal sites and technology available at the site; identity of hauling contractors,
- waste exchange and recycling information.

Recommendations

The emerging technologies evaluated in this study can be considered as alternatives to landfill disposal of hazardous waste. It is presumed that the emerging technologies will destroy the waste or at least attenuate it to acceptable levels. The advantages and disadvantages of each emerging technology presented must be carefully considered when selecting the technology most suitable for the control of specific hazardous wastes is selected.

The information needs for major hazardous waste generators could best be met by the use of a hazardous waste data base supplemented by newsletters and telephone "hotlines."

Hazardous wastes destroyed by emerging technologies

A. Molten salt combustion:

Miscellaneous

PCB's
Chloroform
Perchloroethylene distillation bottoms
Trichloroethane
Tributyl Phosphate
Nitroethane
Monoethanolamine
Diphenylamine HCl
Rubber tire buffings
Para-Arsanilic Acid
Contaminated ion exchange resins (Dowex and Powdex)
High-Sulfur Waste Refinery Sludge
Acrylics Residue
Tannery wastes
Aluminum Chlorohydrate

Pesticides and herbicides

Chlordane
Weed B Gone
DDT powder
Malathion
Sevin
DDT powder with Malathion
2, 4-D Herbicide-Tar Mixed waste

Real and simulated pesticide containers

plastic, rubber, and a blend of these

Feasible pesticides and nitrile herbicides

Pesticides	Nitrile Herbicides
dieldrin	trifluralin
heptachlor	2, 4, 5-T dichlorobinil
aldrin	MCPA
toluidine	

B. Fluidized bed incineration:

Miscellaneous

HCl spent pickling liquor
Organotin in spent steel slag blasting abrasive
Organic dye slurries
  red dye slurry (1-methylaminoanthraquinone and starch gum)
  yellow dye slurry (dibenzpyrenequinone and benzanthrone)

Chlorinated hydrocarbons

PVC waste from a chemical plant
PVC mixed with coal
PVC insulation over copper wire
Chlorinated hydrocarbon waste with 90% chlorine

Munitions (slurry)

TNT
RDX (cyclotrimethylenetrinitramine)
Composition B

C. UV/ozonation technology:

Miscellaneous

PCB's
TCDD (2, 3, 7, 8-tetrachlorodibenzo-p-dioxin)
OCDD (octachlorodibenzo-p-dioxin)
Chlorodioxins (other dioxins are feasible)
Hydrazine
Monomethyl hydrazine
Dimethyl hydrazine (asymmetrical)
Copper process waste stream
Nitrobenzene

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The complete report, entitled "Emerging Technologies for the Control of Hazardous Wastes," (Order No. PB 82-236 993; Cost: $15.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

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Industrial Environmental Research Laboratory
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Technology is in place, but costly

By Herb Greenberg
and Terry Atlas

ONE POSSIBLE solution to the nation's hazardous-waste puzzle lies at the end of a bumpy, mud-covered dirt road on Chicago's South Side.

Behind a 12-foot-high chain-link fence, SCA Chemical Services Inc.'s new $21 million incinerator—the nation's most modern and sophisticated—is capable of destroying some of the most toxic waste now being buried in landfills.

Several miles away in south suburban Harvey, Envirite Corp. provides another solution with its 18-month-old chemical treatment plant. The squeaky clean, white-brick facility—one of the nation's most technologically advanced—was built to neutralize large volumes of acids and cyanides from metalworking shops.

Yet both state-of-the-art plants will be lucky to break even this year, the companies said. That's a tremendous irony given the growing controversy over leaky landfills, the most widely used method for disposing of industry's hazardous wastes.

"Sometimes we can barely operate through a full week because we don't have enough business," said George Kush, director of environmental affairs for SCA.

THE REASON, simply, is economic. The technology exists to recycle, treat or incinerate as much as three quarters of the hazardous wastes currently dumped into landfills, but alternatives for disposing of the most toxic wastes cost as much as four times that for burial.

"The bottom line is the bottom line," Kush said.

But industry is giving greater consideration to paying the higher bills, particularly after the rise of public-health fears created by dump sites and the imposition of federal regulations mandating "cradle-to-grave" tracking of hazardous wastes.

The recent controversy over landfills owned by Oak Brook-based Waste Management Inc., the largest and most highly regarded of the waste-disposal firms, has only sharpened the focus on disposal policies.

INDUSTRY ALSO faces the possibility of tougher regulations, special taxes and increased liabilities. Yet, few have decided to switch entirely to more sophisticated disposal methods.

"A lot of people are going to come up to a rude awakening in terms of handling materials," said John Rademacher, vice president of environmental health and regulatory affairs for Velsicol Chemical Corp., a Chicago company that had a series of environmental problems several years ago. "The penalties are so severe, not only in terms of money, but in terms of image."

With more than 41 million tons of hazardous waste generated annually—20 percent of which is disposed of at landfills or facilities away from production sites—most disposal firms have been anticipating changes in hazardous-waste regulations.

THE FIRST big development occurred in November, 1980, when the federal government began enforcing the Resource Conservation and Recovery Act [RCRA]. The act set guidelines and regulations for the disposal of hazardous waste, making the waste generators liable for what ultimately happens to their garbage.

In anticipation of the new law, firms such as SCA and Envirite built their new plants. Waste Management, the nation's largest private garbage collector, diversified into chemical waste disposal, which now accounts for 13 percent of its revenues.

"When you looked at what RCRA was doing, it was thought that waste generators were going to shift to higher technologies," said Todd Dykton, operations manager for Envirite's Harvey facility.

Both Envirite and SCA thought their plants would quickly work up to full capacity. SCA, based in Boston, also operates a number of landfills.

"We're in one of the biggest metalworking markets in the country," reasoned Dykton, whose facility specializes in byproducts from the metals industry.

BUT RCRA was so complex—and enforcement so lax—that most companies that shipped their toxic waste continued to choose landfills over plants such as Envirite's and SCA's, which are operating at less than half capacity.

While there are no national figures on precisely where waste goes—it varies by state—there's some evidence that disposal practices may be changing. In highly industrialized Illinois, for instance, figures from the state Environmental Protection Agency show that 40 percent of the waste shipped from plants goes into

* Excerpted from " Toxic Waste Dumps: Economics Choking Alternatives", Chicago Tribune, Apr. 17, 1983, sec. 5: 1, 9. Reproduced with the permission of the copyright holder.

Toxic waste

Continued from 1st Business Page

landfills. In Louisiana, the figure is 97 percent.

A surprisingly high 17 percent of the Illinois waste is chemically treated while 2.5 percent is incinerated, reflecting the small number (three) of incinerators.

State officials expect incineration to increase as a result of the addition of SCA's incinerater, which opened last year.

THERE ARE several other reasons to expect a shift away from landfills:

- Public protests against landfills, such as the troubles at Waste Management's sites, are simply unlikely to go away. As a result, no new landfills are being built, and the outlook for more isn't good. In the last three years, "you can count on your hand" the number of new permits for hazardous-waste landfills, according to one official of the federal EPA.

In Illinois, the number of active landfills has dropped to four from seven last year. "Under the best of circumstances, [allowing a new landfill] is a bitter political pill to swallow," said Harold Gershowitz, Waste Management senior vice president. "There's no percentage in an elected official speaking on behalf of a hazardous-waste disposal site and a large percentage in opposing one."

Further, areas that have landfills fear becoming dumping grounds for wastes from other parts of the country. "People are afraid of anything called hazardous waste," Gershowitz said. "They are afraid of it being treated near where they live or work, being transported near where they live or work or being disposed of near where they live or work."

- A study by the Congressional Office of Technology Assessment recommends that the use of landfills be minimized because of the long-term risks of groundwater contamination. A recent EPA study concluded that more than 60 percent of the nation's hazardous-waste storage, treatment and disposal facilities surveyed fail to meet RCRA groundwater monitoring rules. "I would say there's still a lot of waste out there that needs to be brought into compliance," said John Skinner, head of EPA's solid-waste division.

Even the most advanced landfills are susceptible to problems. Last week, the Michigan Department of Natural Resources ordered Dow Chemical Co. to stop using a year-old landfill in Midland after an apparent leak. The alleged violations occurred when hazardous wastes being pumped in the 152-acre landfill backed up and entered a "clean zone" under the landfill's five-foot clay liner. The clean zone is designed as a pollution detection system to check for leakage from the landfill.

- Regulations are sure to be tightened as a result of legislation either pending or abou: to be introduced in Congress. One proposal receiving attention is a tax on waste dumped in landfills. Backers of such a tax see it as an economic incentive to use alternate methods of disposal.

- Because generators of waste can be held responsible for cleaning up a leaky dump, liability is likely to be of greater concern. Last year, for instance, 24 companies agreed to pay $320,000 each to clean up a deteriorating landfill in Seymour, Ind.

A SMALL NUMBER of companies are beginning to treat waste or incinerate it, but they're more the exception than the rule. And they tend to be larger companies that have had problems in the past.

One such company, Velsicol, has adopted the policy of incinerating all liquid wastes, and is moving toward burning even its toxic solid wastes. A number of years ago the company buried 150,000 barrels of pesticide waste in a Tennessee landfill that wound up leaking into an aquifer.

"We paid a big price for burying material and having it come back to haunt us," Velsicol's Rademacher said. "We don't want to have any of that in the future."

But the vast majority of companies still base their decisions on the initial cost and wind up using landfills. According to the study by the Office of Technology Assessment, it costs $240 to bury one ton of the most toxic waste in a landfill and $791 to incinerate it or treat it.

HOWEVER, said E.H. Hurst, vice president of environmental health and safety for Nalco Chemical Co.: "We just don't call folks up and say, 'I got a load, come and get it.' From now on we're going to do business with better-known companies. We're going to find out something about their operations."

Moreover, because of the liability issue, some companies are trying to reduce waste volumes in part by processing and recyling.

But as a result of the alleged problems with dumps operated by a company as experienced as Waste Management, some of the larger waste-generating companies are becoming uncomfortable about the reliability and availability of disposal away from their plants.

Standard Oil Co. (Indiana), for instance, in many cases treats, incinerates or buries wastes at its major refinery and chemical operations. Its big Amoco refinery at Whiting operates an incinerator to dispose of the sludge from its sewage treatment plant. Nalco has two incinerators in operation that it didn't have seven years ago.

EVEN NEW technology isn't without potential controversy. Burning or treating wastes in some cases produces a residue that still must be buried. Further, the public doesn't want incinerators or treatment plants nearby. "We see as much opposition to new proposals for incinerators as we see for new land sites," said Waste Management's Gershowitz.

In both Texas and Delaware, groups of residents have objected to Waste Management's two incinerator ships, which propose burning waste more than 100 miles offshore in the Atlantic and Gulf of Mexico. Despite studies by the EPA and others documenting the total destruction of wastes on the ships, people fear their emissions as well as a possible spill during shipment.

Another problem is the lack of proposed new treatment or incinerating facilities. With an incinerator costing more than $20 million and a first-rate treatment plant costing about $5 million, potential operators are holding back further plans until the facilities now in operation prove profitable.

"Why would someone else site a treatment plant here considering that treatment plants are having such a difficult time?" asked Envirite's Dykton.

BUT IN SOME cases, not even the most advanced technology can help.

The environmental-affairs director for the chemical products division of one large Illinois manufacturer, who didn't want to be identified, complains he can't get incinerators to take his waste.

Since the company's chemical plant is relatively new, it recycles more waste than it generates. Because its volumes are so low—barrels, not truckloads—the incinerators consider it too costly to process.

"We've recycled ourselves into a hole," said the company official, adding: "When it's all said and done, you've got a changing world. But it's not geared up to accept the change."

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Project Summary

Costs of Remedial Response Actions at Uncontrolled Hazardous Waste Sites

Howard L. Rishel, Terence M. Boston, Curtis J. Schmidt, and Oscar W. Albrecht

This study updates previously estimated costs for remedial response actions at uncontrolled and abandoned hazardous waste disposal sites. Costs for 35 remedial action operations were estimated for the United States and for the Newark, New Jersey, area. These estimates were based on mid-1980 price levels.

Cost components for capital and operating expenses were estimated for independent unit operations, and total and life cycle average costs were computed. An example is included to show the user how to estimate costs for complete remedial response activities.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Past disposal of hazardous wastes is one of the very serious problems facing the Nation today. Wastes at uncontrolled and abandoned disposal sites contain toxic, reactive, ignitable, corrosive, and persistent hazardous substances that pose significant risks to public health and the environment.

To deal with potential risks, Congress passed in 1980 the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), frequently referred to as the "Superfund." The Act calls for a broad response and liability mechanism for dealing with toxic substances pollution and requires the U.S. Environmental Protection Agency (EPA) to identify the hazardous substances and reportable quantities of such substances that may escape to the environment. The Act further provides for government response to actual and threatened releases, determination of the liability of polluters, and a joint government-industry response fund to cover costs for cleanup and restoration.

To assist those involved in estimating the costs of remedial response actions (e.g., containment, cleanup, and restoration), EPA sponsored this study to review and update engineering designs and related costs. The tasks included identification of appropriate designs from the available literature and revision of the associated capital and operating costs to reflect recent prices. Individual costs were estimated for unit operations (specific types of remedial actions), and these were then combined for estimating the costs of complete remedial action responses at uncontrolled or abandoned landfills or impoundment sites. The full report includes the following:

- Conceptualized descriptions of the uncontrolled landfill and surface impoundment disposal sites;
- Generalized discussions of the 35 unit operations (21 for landfills and

Table 1. Average U.S. Low and High Costs of Unit Operations for Medium-Sized Landfill Sites

Unit Operations	Unit	Average U.S. Cost $ Per Unit*				Total Units Used**
		Initial Capital		Life Cycle Costs		
		Low	High	Low	High	
1. Contour grading and surface water diversion	Site area, ha	16,300	17,900	16,300	19,900	5.4 ha site area
2. Bituminous concrete surface sealing	Site area, ha	67,300	92,700	67,300	92,700	5.4 ha site area
3. Revegetation	Site area, ha	3,450	16,500	14,300	18,100	5.4 ha site area
4. Bentonite slurry trench	Wall face area, m²	54.5	96.1	61.2	103	10,800 m² wall face area
5. Grout curtain	Wall face area, m²	600	1,209	937	1,880	10,800 m² wall face area
6. Sheet piling cutoff wall	Wall face area, m²	73	108	73	108	10,800 m² wall face area
7. Grout bottom sealing	Site area, ha	5,282,000	10,209,000	5,296,000	10,224,000	5.4 ha site area
8. Drains	Pipe length, m	72.7	106	367	416	260 m pipe length
9. Well point system	Intercept face area, m²	62.5	105	107	153	2,000 m² intercept face area
10. Deep well system	Intercept face area, m²	11.6	18.3	28.6	37.2	4,800 m² intercept face area
11. Injection	Intercept face area, m²	77	90	1,760	1,786	550 m² intercept face area
12. Leachate recirculation by subgrade irrigation	Site area, ha	5,270	8,360	19,700	24,000	5.4 ha site area
13. Chemical fixation	Site area, ha	69,100	130,000	82,500	145,000	5.4 ha site area
14. Chemical injection	Landfill volume, m³	1.67	3.28	2.16	3.81	150,000 m³ landfill volume
15. Excavation and reburial	Landfill volume, m³	116	120	116	120	596,000 m³ landfill volume
16. Ponding	Site area, ha	547	1,028	647	1,028	5.4 ha site area
17. Trench construction	Trench length, m	12.2	14.34	15.11	20.32	930 m trench length
18. Perimeter gravel trench vents	Trench length, m	99.2	144	100	146	935 m trench length
19. Treatment of contaminated ground water	Contaminated water, L/d	1.52	2.57	2.52	4.38	440,740 L/d contaminated water
20. Gas migration control - passive	Site perimeter, m	161	241	168	256	935 m site perimeter
21. Gas migration control - active	Site perimeter, m	113	173	167	279	935 m site perimeter

* Mid-1980 dollars, 10-year life cycle. O & M costs are discounted at 11.4% to present value, capital costs are not amortized.
** For 5.4 ha site.

14 for surface impoundments), and the methodology for cost estimation;

- Detailed cost information for each of the 35 unit operations and their components;
- Cost estimation examples for complete remedial/response scenarios;
- Evaluation of scale economies and regional variation of costs; and
- Unit costs for all capital and O&M components.

Findings

The updated cost estimates are useful for preliminary comparisons of costs for alternative unit operations that perform the same function. The unit operation costs can be combined to estimate total costs of complete remedial response actions. The user is cautioned however, that the approach is only a first approximation of total costs, as many components are affected by site-specific considerations. Considerable additional research in evaluating technical cost differences is needed. As more remedial response activities at uncontrolled and abandoned sites are undertaken, the cost estimates should be modified to reflect more nearly the actual conditions. Average cost estimates for medium-sized sites are presented in Tables 1 and 2 for landfills and surface impoundments, respectively.

Conclusions and Recommendations

Little is known about the actual costs involved in cleanup at uncontrolled and abandoned hazardous waste disposal sites. The literature on remedial response activities refers mostly to a national and industrywide approach. Cost information, where available, is highly aggregated. Critical components of cost are frequently omitted. This study attempts to overcome some of these deficiencies.

The primary product of this study is a cost estimating methodology that can be consistently applied to each of the identified unit operations. The resulting cost estimates can be used to compare costs for alternative remedial response actions that perform the same function (e.g., prevent infiltration) and to compute combined cost estimates for operations that constitute a complete remedial response scenario. The user is cautioned, however, that a simple comparison of these costs does not address the many technical differences in the capabilities or efficiencies of alternative operations under site-specific conditions. The site profiles used for this study were conceptualizations of general environmental settings; thus they

Table 2. Average U.S. Low and High Costs of Unit Operations for Medium-Sized Surface Impoundment Sites

Unit Operations	Unit	Average U.S. Cost $ Per Unit*				Total Units Used**
		Initial Capital		Life Cycle Costs		
		Low	High	Low	High	
22. Pond closure and contour grading of surface	Site area, ha	26,900	35,100	35,900	53,500	0.47 ha site area
23. Bituminous concrete surface	Site area, ha	48,500	70,700	48,500	70,700	0.47 ha site area
24. Revegetation	Site area, ha	2,540	3,820	3,970	5,450	0.47 ha site area
25. Slurry trench cutoff wall	Wall face area, m²	60.1	106	60.1	106	4,165 m² wall face area
26. Grout curtain	Wall face area, m²	326	631	343	649	4,104 m² wall face area
27. Sheet piling cutoff wall	Wall face area, m²	76.8	115	94.6	135	4,100 m² wall face area
28. Grout bottom seal	Site area, ha	868,000	1,621,000	1,024,000	1,792,000	0.47 ha site area
29. Toe and underdrains	Pipe Length, m	316	609	1,550	1,960	60 m pipe length
30. Well point system	Intercept face area, m²	63.3	117	321	398	300 m² intercept face area
31. Deep well system	Intercept face area, m²	33.2	60.3	114.4	149	950 m² intercept face area
32. Well injection system	Intercept face area, m²	31.3	55.5	109	141	950 m² intercept face area
33. Leachate treatment	Contaminated water, L/d	1.16	1.96	4.49	8.14	51,870 L/d contaminated water
34. Berm reconstruction	Replaced berm, m³	2.98	3.80	4.00	5.86	410 m³ berm
35. Excavation and disposal at secure landfill	Impoundment volume, m³	260	268	260	268	5,000 impoundment volume

* Mid-1980 dollars, 10-year life cycle, O & M costs are discounted at 11.4% to present value, capital costs are not amortized.
** For 0.47 ha impoundment.

do not necessarily represent actual site conditions.

Complete remedial response action for uncontrolled or abandoned hazardous waste disposal sites typically consists of at least several unit operations. Scale economies may exist when multiple unit operations requiring similar component inputs are performed, but the extent of these economies is unknown and needs to be researched. Furthermore, additional research is needed on short- and long-term remedial response actions to address the net benefits as well as the costs to society.

The full report was submitted in fulfillment of Contract No. 68-01-4885 by SCS Engineers under the sponsorship of the U.S. Environmental Protection Agency.

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The complete report, entitled "Costs of Remedial Response Actions at Uncontrolled Hazardous Waste Sites," (Order No. PB 83-164 830; Cost: $16.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

For information contact ***Donald E. Sanning*** *at:*

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U.S. Environmental Protection Agency
Cincinnati, OH 45268

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What Monitor Wells Can and Cannot Do

Monitor well systems for detecting ground water contaminants include several shortcomings of technology and procedure.

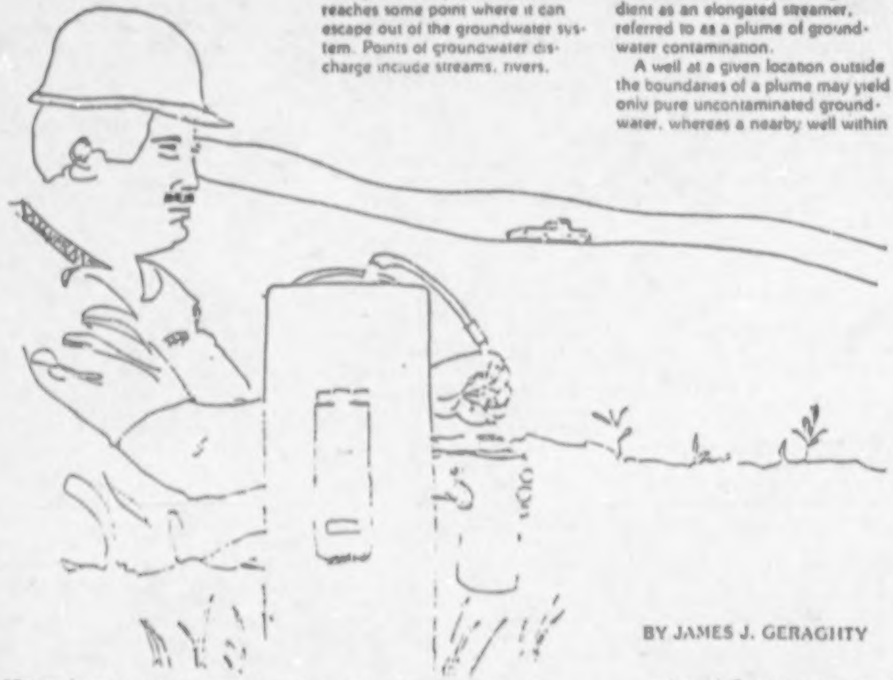
Any ground water system always is in a more or less hydraulic balance, in the sense that water entering the system continuously moves through the earth to some point of discharge so that new water can enter.

After rainwater has moved downward into the water-table zone, it begins to flow, mostly laterally, following what hydrologists call the water-table gradient, or slope.

The groundwater travels at slow rates, commonly measured in terms of a fraction of an inch to perhaps a couple of feet per day, until it reaches some point where it can escape out of the groundwater system. Points of groundwater discharge include streams, rivers, bays, lakes, swamps, and oceans, and most importantly, wells used for water-supply purposes. In many instances, the pumping from water wells changes natural groundwater flow patterns radically, in effect pulling groundwater into the wells. Thus, contaminated liquids that enter an aquifer may pose a threat to public health where water wells are in operation nearby.

Contrary to common belief, contaminated liquids in a groundwater system do not mix easily with the native groundwater. Instead they tend to follow the hydraulic gradient as an elongated streamer, referred to as a plume of groundwater contamination.

A well at a given location outside the boundaries of a plume may yield only pure uncontaminated groundwater, whereas a nearby well within



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the plume boundaries may be withdrawing contaminated groundwater.

The real problem is how to find plumes in the hidden subsurface environment in order to derive some early warning of the threat posed by the contamination.

Monitor wells

A basic requirement of the EPA regulations is that monitor wells be installed at new landfill sites, drilled and located in such a way that any contaminants seeping from the landfill will ultimately move into the wells and be detected through sampling and water analysis. The idea is that the monitor wells initially may yield only uncontaminated water, but that ultimately, after the landfill has been in operation for some time, may detect degradation of the groundwater caused by downward seepage of contaminants

EPA has not yet established precise guidelines on how to locate and install the monitor system, but simply indicates that at least one monitor well be upgradient from a landfill site and at least several monitor wells be located in the downgradient direction.

> ***"Contrary to common belief, contaminated liquids do not mix easily with native ground water."***

The logic is that water moving naturally through the earth toward a landfill normally will be uncontaminated, whereas water emerging from beneath the landfill in the downgradient direction may become contaminated.

In the prescribed monitoring-well procedures, all of the wells are to be sampled periodically, with the analyses from the downgradient wells being averaged and compared with the analyses from the upgradient wells. If a plume is discovered, the owner or operator of the landfill then must take further action to either define in detail the plume dimensions and concentrations of contaminants, or to begin some type of remedial program to halt or reverse the slow drift of the contaminants toward nearby water wells.

Checklist for monitor well sampling

- Check equipment; make arrangements with laboratory and for sample transportation.
- Measure the static water level in the well.
- Flush the well to remove standing water. An amount equal to five times the volume of the casing should be removed in high-yield formations. (In low permeability strata, one volume will suffice.)
- Allow the well to recharge to the static water level, which may require more than one day.
- Clean and/or flush sampling equipment with distilled or drinking water between samples.
- Where appropriate, filter the sample during collection. Non-aerated conditions must be maintained; therefore, do not allow the water to bubble or splash into the sample container and filter.
- Preserve the sample and pack it in ice if necessary for shipment.
- Clean equipment. Make sure well is securely capped.

Shortcomings of system

In recent years, several shortcomings of monitor well systems have become apparent. First, at many landfill sites, contaminants already may be present in the groundwater system as a result of seepage from some other source.

It is not uncommon to find that upgradient wells are contaminated to the same degree as downgradient wells, simply because the groundwater moving toward the landfill already has been degraded through operations of one kind or another. In such cases, it obviously becomes difficult to be able to assess the extent of contamination, if any, caused by the landfill itself.

In addition to landfills, other sources of groundwater contamination include municipal and industrial surface impoundments, leaky sewer lines, buried oil storage tanks, applications of pesticides and herbicides on agricultural lands, cesspools, and septic tanks, and poor housekeeping in places where contaminants are stored or used on the land surface. A rough estimate is that bodies of subsurface contamination originating from such sources in the United States probably number in the millions, with only a tiny percentage of them ever having been drilled into and adequately evalutated.

A second shortcoming is that a typical monitor well does not pull in water from a great distance during a short sampling interval, but instead takes water from a very restricted zone that may extend outward no more than a few feet from the well. Thus, a monitor well could be only a short distance from a plume of contamination but still deliver perfectly fresh groundwater not showing any evidence of the existence of the plume.

Sample is diluted

Another shortcoming is that it is almost impossible to pump from a monitor well penetrating a plume of contamination without drawing in some uncontaminated groundwater from nearby. As a result, the water analysis returned from the laboratory may show concentrations of chemical contaminants below those in the plume, simply because both fresh water and contaminated water have been mixed inside the well before being brought up to the land surface.

Evidence along these lines suggests that may of the chemical analyses now being turned in to regulatory agencies show less contamination than actually exists in specific plumes of contamination.

The rate of flow of groundwater also may be so slow that repeated sampling over many months or even years will show little or no net change in chemical concentrations in the water. In other words, sampling at frequent intervals may be of dubious value if the contaminated groundwater is not capable of moving more than a few inches or perhaps a couple of feet over the course of many months.

Still another deficiency of some monitor-well systems is that the metals or plastics used in constructing and sealing a well may contribute trace amounts of contaminants to the water being pumped, misleading the investigator into thinking that the groundwater is contaminated. Also, if the well has not been properly sealed into the ground, potentially contaminated water from the land surface may move directly downward along the outside of the well, again giving a false clue to groundwater contamination.

> ***"The real problem is how to find plumes of contamination in the hidden subsurface environment."***

Monitor well technology in summary offers a safeguard against groundwater contamination, but the protection is far from complete and the methods in practice suggest the need for continuing improvements.

Constructing monitor wells

In order to allow states to identify open dumps, the EPA in 1980 issued the *Guidance Manual for Classifying Solid Waste Disposal Facilities* (SW828). Eighteen states assisted EPA in the development of the manual. Assistance was also provided by the National Solid Wastes Management Association, the Governmental Refuse Collection and Disposal Association, and the American Public Works Association.

The manual makes the following statements with regard to monitor-well placement and construction.

The system should have a minimum of one well hydraulically upgradient from the site and at least two downgradient. Test borings or geophysical studies may have to be made to determine the water-table gradient and location.

The downgradient wells should be located as close as practicable to the solid waste boundary without being drilled through the waste. Downgradient wells should be placed at the point where contamination is most likely.

Upgradient and downgradient wells should be located so that samples are obtained from the same horizon of water-bearing material.

Well casing should be a minimum of two inches in diameter, and preferably four inches, to allow for ease of pumping and sampling.

A bentonite clay or cement seal or plug should be in place around the casing.

The well should be finished at the surface with a cement or earth mound sloped away from the well to prevent surface drainage down the casing.

For most wells less than 100 feet in depth, casing and well screens should be plastic, unless the waste type involved contains organic pollutants or is corrosive to plastic. In these instances, it will be necessary to use steel well casing, which, however, may give misleading analyses for concentrations of metals. In wells deeper than 100 feet, steel casings and stronger screens should be used to prevent compression and closing of the casing and screen. **WA**

HEALTH EFFECTS

Accurately specifying the health effects of contact with toxic substances is very difficult. Several inorganic contaminants (arsenic, cadmium, chromium and nickel) are known to cause cancer in humans (Samuel Epstein, *The Politics of Cancer*), and others are suspected human carcinogens. Many organic chemicals are known or suspected to cause cancer, but most have never been adequately tested. Degree-of-risk estimates are difficult and uncertain, but the CEQ mentioned one well where it was estimated that lifetime consumption of the water would lead to one chance in 400 of cancer. "Stated another way, if a population of 1 million were to consume this water for a lifetime, an additional 2,590 people would contract cancer in their lifetimes." (CEQ, p. 70).

Health effects other than cancer are difficult to estimate because so many studies have focused either on short-term acute effects or else on industrial exposures through routes other than drinking water. Some information is available to help identify the broad range of symptoms and problems that may be relevant. Table 1 lists some of the known health effects of some of the most frequent contaminants in groundwater.

* Reproduced from Poisons in the Water: The Reagan Administration and Toxic Dump Cleanup. San Francisco, Sierra Club, 1982: 20-24. (Sierra Club. National Heritage report no. 5)

Table 1. Reported Effects of Commonly-Found Contaminants in Groundwater (not necessarily effects from drinking)

Substance	Acute Effects	Chronic Effects	Carcinogenicity Mutagenicity Reproductive Effects
Organics:			
Benzene	death; nausea, giddiness, headache, unconsciousness, convulsions, paralysis	thrombocytopenia, leukopenia, myelocytic anemia, leukemia (cumulative)	leukemia
Benzene hexachloride (mixture of isomers) (BHC) (including Lindane)	(hyperirritability, convulsions, incoordination)*	chronic liver damage; aplastic anemia; (nervous symptoms, degeneration of liver and kidney)	leukemia? (carcinogenic in mice and rats)
Bromoform	No data on effects on humans.		
	(liver and kidney effects)	(disorders in prothrombin synthesis and glycogenesis in liver; reduced renal filtration)	weakly positive in *Salmonella* test for mutagenicity
Carbon tetrachloride	death; liver damage; kidney shutdown; heart failure; centrilobular necrosis	gastrointestinal: nausea, vomiting; nervous system: headache, drowsiness, fatigue, apathy, mental confusion, weight loss	carcinogen, teratogen
Chloroform	Primarily affects the liver; also kidney and heart; skin reaction	reversible toxicity to liver	(probably carcinogenic in mice and rats)
Di-butyl-phthalate (DBP)	nausea, giddiness, eyes inflamed, toxic nephritis, blood in urine		(birth defects, reproductive disturbances)
1,2-Dichloroethane	death; irritation of eyes, nose, throat; central nervous system depression; injury to liver, kidneys, adrenals	(liver and kidney damage)	weak mutagen

Table 1. (continued)
Reported Effects of Commonly-Found Contaminants in Groundwater

Substance	Acute Effects	Chronic Effects	Carcinogenicity Mutagenicity Reproductive Effects
Organics:			
Methyl chloride	(death)	(neuromuscular effects, decreased survival; anemia; reticulocytosis; nervous system and eye effects)	no data
Methylene chloride		(slight weight reduction; some liver injury)	limited data, may be carcinogen
Parathion	death; depression of cholinesterase		mutagen
Tetrachloroethylene	central nervous system effects		limited data
Toluene	narcotic effect	mild red cell decrease; enlarged liver; (nervous system intoxication, incoordination)	
1,1,2-Trichloroethane	(liver and kidney effects)		(possibly carcinogenic)
Trichloroethylene	central nervous system depression, incoordination, unconsciousness; nausea, vomiting, blurred vision; death; permanent impairment of mobility	(increased liver and kidney weights)	(carcinogenic in mice)
Vinyl chloride	central nervous system dysfunction, sympathetic-sensory polyneuritis; organic disorders of brain	skin alterations; Reynaud's syndrome; acroosteolysis; lesions of skin, bones, liver, spleen, lungs	carcinogen, angiosarcoma (mutagen, cancer in rats)

Table 1. (continued)
Reported Effects of Commonly-Found Contaminants in Groundwater

Substance	Acute Effects	Chronic Effects	Carcinogenicity Mutagenicity Reproductive Effects
Organics:			
Xylene	death; confusion; renal impairment, liver damage	skin irritation; incoordination; decreased white blood cells; hyperplastic bone marrow and spleen; kidney congestion	(developmental defects in chicken embryos)
Inorganics:			
Arsenic	death; abdominal pain, vomiting, cramps, spasms, restlessness, etc.	cumulative toxin; skin reactions; vomiting, diarrhea, conjuctivitis, laryngitis, bronchitis; neurological symptoms; muscle tenderness; congestive heart failure; possibly suppresses some immune responses, etc.	carcinogenic, mutagenic (birth defects in mice and hamsters)
Cadmium	gastrointestinal upsets	cumulative toxin; bronchitis, emphysema, anemia, kidney stones; (hypertension)	may be carcinogenic (carcinogenic, teratogenic, testicular and ovarian necrosis in rats)
Chromium	tubular necrosis of kidney	cumulative toxin; hemorrhage of gastrointestinal tract; ulceration	carcinogenic
Lead		cumulative toxin; disturbances of hemapoietic system; central and peripheral nervous system; kidneys; mental defects in children	(carcinogenic in rats, mutagenic, teratogenic) effects on sperm production

Table 1. (continued)
Reported Effects of Commonly-Found Contaminants in Groundwater

Substance	Acute Effects	Chronic Effects	Carcinogenicity Mutagenicity Reproductive Effects
Inorganics:			
Mercury		cumulative toxin; kidney damage; intestinal hemorrhage, ulceration; mental disturbance; ataxia, disturbance of gait, speech, hearing, chewing and swallowing, constriction of visual field, etc. – "Minamata disease"	birth defects

NOTES:
*Entries in parentheses are derived from animal data.

This table is based on health data surveyed in *Drinking Water and Health* by the Safe Drinking Water Committee of the National Research Council (NRC – National Academy of Sciences, 1977) with very limited supplementation from Dodge *et al.* ("A Brief Review of Selected Environmental Contamination Incidents With a Potential for Health Effects") and Irving Sax, (*Dangerous Properties of Industrial Materials*, 1979, Van Nostrand-Reinhold). The purpose of this list is not to give usable toxicological information (that would require reference to dosage, route of administration, and many more details than can be described here), but merely to illustrate the wide and serious range of effects known to be caused by the same chemicals found in drinking water.

The organic chemicals listed represent the overlap between the CEQ's list of synthetic organic contaminants most frequently found in drinking wells reported in *Contamination of Groundwater by Toxic Organic Chemicals* (1981), and the compounds listed in *Drinking Water and Health*. In addition, we have included five of the most dangerous inorganic elements.

A final caution is that even less is known about the effects of the complex mixtures of poisons that actually occur in groundwater (though a few were surveyed by the Surgeon General in *Health Effects of Toxic Pollution*). Many of the true interactions are not known, but it seems a safe guess that in some cases the mixtures will produce augmented synergistic effects greater than would be expected from simply adding the effects of the individual substances.

XI. Hazardous Waste

(Source: Solid Waste Data - A Compilation of Statistics on Solid Waste Management Within the United States, Washington, D.C., U.S. Environmental Protection Agency, 1981; pp. 61-66.)

XI-1 ESTIMATED HAZARDOUS WASTE GENERATION BY INDUSTRY, 1980

SIC Code	Industry	Quantity (wet kkg)	Percent
22	Textile Mill Products	203,000	0.5
24	Lumber and Wood Products	87,000	0.2
25	Furniture and Fixtures	36,000	0.09
26	Paper and Allied Products	1,295,000	3.1
27	Printing and Publishing	156,000	0.4
28	Chemicals and Allied Products	25,509,000	61.9
29	Petroleum and Coal Products	2,119,000	5.1
30	Rubber and Misc. Plastic Products	249,000	0.6
31	Leather and Leather Tanning	474,000	1.1
32	Stone, Clay and Glass Products	17,000	0.04
33	Primary Metal Industries	4,061,000	9.8
34	Fabricated Metal Products	1,997,000	4.8
35	Machinery, Except Electrical	322,000	0.8
36	Electrical and Electronic Equipment	1,093,000	2.7
37	Transportation Equipment	1,240,000	3.0
38	Instruments and Related Products	90,000	0.2
39	Misc. Manufacturing Industries	318,000	0.8
--	Non-Manufacturing Industries[1]	1,971,000	4.8
TOTAL		41,235,000	99.9[2]

Data compiled by JRB Associates.

[1] SIC 5085-Drum Reconditioners, SIC 07-Agricultural Services, SIC 5161-Chemical Warehouses, SIC 40-Railroad Transportation, SIC 55-Automotive Dealers and Gasoline Service Stations, SIC 72-Personal Services, SIC 73-Business Services, SIC 76-Misc. Repair Services, SIC 80-Health Services, SIC 82-Educational Services.

[2] Does not total 100% due to rounding error.

Source: USEPA: *Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment*, SW-894; Prepared by Booz, Allen, and Hamilton; Putnam, Hayes, and Bartlett, Inc.; Washington, D.C., 1980.

XI-2 INDUSTRIAL HAZARDOUS WASTE GENERATION BY REGION, 1980

EPA Region	Quantity (wet kkg)	Percent
I	1,104,000	2.7
II	3,113,000	7.5
III	4,354,000	10.6
IV	10,353,000	25.1
V	6,428,000	15.6
VI	10,536,000	25.5
VII	1,201,000	2.9
VIII	318,000	0.8
IX	2,838,000	6.9
X	995,000	2.4
TOTAL	41,240,000[1]	100

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[1] Quantity estimated at 41,235,000 wet kkg; the difference is due to rounding. Range reported by source was 27,765,000 wet kkg - 53,864,000 wet kkg.

Source: USEPA: Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment, SW-894; Prepared by Booz, Allen, and Hamilton; Putnam, Hayes, and Bartlett, Inc.; Washington, D.C., 1980.

XI-3 ESTIMATED HAZARDOUS WASTE GENERATION BY WASTE TYPE, 1980

Waste Type[1]	Quantity (wet kkg)	Percent (%)
Sludges	9,428,258	26.5
Solvents	2,344,701	6.6
Alkali/Caustic	1,526,590	4.3
Acid	711,150	2.0
Heavy Ends	328,390	0.9
Bottoms	281,760	0.8
Other	20,919,750	58.9
TOTAL	35,540,599[2]	100

Data compiled by JRB Associates.

[1] Excludes non-manufacturing category (1,965,844 kkg) for which no breakdown is available.

[2] According to the source report for this table, 1980 hazardous waste generation is estimated to be 37,506,443 kkg. This is less than the Booz-Allen and Hamilton value reported in source 27 (41,235,000 kkg); however, it falls within their reported generation range (27,765,000-53,864,000 kkg).

Source: USEPA: Impact Analysis of Proposed RCRA-FSS Regulations, 1980-1990, Prepared by Development Planning and Research Associates, Inc.; Pope-Reid Associates, Inc.; Putman, Hayes, and Bartlett, Inc.; and Temple, Barber and Sloane, Inc., 1980.

XI-4 HAZARDOUS WASTE COMPOSITION BY SIC CODE, 1980

SIC CODE	Waste Type (%) Solvents	Sludges	Acid	Alkali/Caustic	Heavy Ends	Bottoms	Other
22	0.6	99.4	—	—	—	—	—
24	—	100.0	—	—	—	—	—
25	12.8	—	—	—	—	—	87.2
26	—	100.0	—	—	—	—	—
27	30.0	—	—	—	—	—	70.0
28	2.9	5.0	2.7	6.4	1.5	0.6	81.0
29	—	81.2	—	—	—	7.8	11.0
30	38.0	—	—	—	—	—	62.0
31	—	75.9	—	—	—	—	24.1
32	—[1]	—	—[1]	—[1]	—	—	100.0
33	4.6	54.5	3.2	2.7	—	—	35.0
34	30.0	50.0	—	—	—	—	20.0
35	30.3	50.5	—	—	—	—	19.2
36	16.4	72.6	—	—	—	—	11.0
37	30.0	50.0	—	—	—	—	20.0
38	29.1	50.6	—	—	—	—	20.3
39	30.2	50.0	—	—	—	—	19.8

Non-Manufacturing -- No breakdown available

Data compiled by JRB Associates.

[1] Process wastes include solvents, alkalines, and acids however the total quantity generated was not broken down by type.

[2] "Other" category represents numerous waste type categories (such as dyes, inks, specific chemicals, spills, etc.) that were not broken down for this table as well as the quantity of wastes under a particular industry that were not broken down by waste type.

Source:

USEPA: Impact Analysis of Proposed RCRA-FSS Regulations, 1980-1990, Prepared by Development Planning and Research Associates, Inc.; Pope-Reid Associates, Inc.; Putman, Hayes, and Bartlett, Inc.; and Temple, Barber and Sloane, Inc., 1980.

XI-5 HAZARDOUS WASTE TRANSPORTERS BY REGION, 1980

EPA Region	Number of Transporters
I	627
II	1,062
III	1,086
IV	1,769
V	2,398
VI	1,267
VII	630
VIII	457
IX	1,132
X	348
TOTAL	10,776

Source: USEPA: Hazardous Waste Data Management System, 1980.

XI-6 ESTIMATED ON-SITE AND OFF-SITE DISPOSAL OF HAZARDOUS WASTE, 1980

EPA Region	Disposal (thousand wet kkg)		
	On-Site	Off-Site[1]	Unknown
I	437	299	368
II	1,921	652	540
III	3,280	604	470
IV	8,766	913	674
V	3,561	1,330	674
VI	8,983	1,029	1,537
VII	716	252	524
VIII	151	106	233
IX	1,792	535	61
X	406	348	511
TOTAL	30,013 (72.8%)	6,068 (14.7%)	5,159 (12.5%)

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[1] Although the disposal site distribution of 12.5% of the total waste generated is unknown, source estimates that approximately 23% of the hazardous waste generated is disposed off-site.

Source: USEPA: Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment, SW-894; Prepared by Booz, Allen, and Hamilton; Putnam, Hayes, and Bartlett, Inc.; Washington, D.C., 1980.

XI-7 METHODS FOR OFF-SITE DISPOSAL OF INDUSTRIAL HAZARDOUS WASTE, 1980

Disposal Method	Estimated Quantity (wet kkg)	Percent
Landfill	2,699,000	37.5
Chemical, Biological, and Physical Treatment	2,116,000	29.4
Deep Well Injection	788,000	11.0
Land Treatment/ Solar Evaporation	537,000	7.5
Resource Recovery	424,000	5.9
Incineration	398,000	5.5
Landfill for Chemical Treatment Wastes	230,000	3.2
TOTAL	7,192,000	100

Source: USEPA: Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment, SW-894; Prepared by Booz, Allen, and Hamilton; Putnam, Hayes, and Bartlett, Inc.; Washington, D.C., 1980.

XI-8 ESTIMATED OFF-SITE HAZARDOUS WASTE TREATMENT/DISPOSAL BY REGION, 1980

EPA Region	Type of Treatment/Disposal Method (thousand wet kkg)						
	Landfill	Land Treatment/Solar Evaporation	Incineration	Chemical[1] Treatment	Resource Recovery	Deep-Well Injection	Total Quantity
I	6	-	23	81	35	-	145
II	375	-	26	619	135	-	1,155
III	170	-	48	467	51	-	736
IV	226	-[2]	65	157	22	-	470[2]
V	330	-	97	486	170	152	1,235
VI	650	117[2]	98	146	-	635	1,646[2]
VII	62	-	-	36	3	-	101
VIII	-[3]	-	-	-	-	-	-[3]
IX	822	345	40	294	-	-	1,501
X	59	75	-	62	8	-	204
TOTAL	2,699	537	398	2,346	424	788	7,192

Detail may not add to total due to rounding.

[1] These are gross volumes and include 10 percent of which will require further treatment.
[2] Volume data from Region IV is included in Region VI to prevent disclosure of confidential data.
[3] Although some landfills in the region may handle hazardous waste, these facilities are not included in the data for this table.

Source:

USEPA: Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment, SW-894; Prepared by Booz, Allen, and Hamilton; Putnam, Hayes, and Bartlett, Inc.; Washington, D.C., 1980.

XI-9 REGIONAL BREAKDOWN OF HAZARDOUS WASTE TREATMENT/DISPOSAL FACILITIES, 1980

EPA Region	Type of Treatment/Disposal Practice (number of facilities)[1] Landfill	Land Treatment/Solar Evaporation	Incineration	Chemical Treatment	Resource Recovery	Deep-Well Injection	Total Number of Facilities
I	1	0	3	3	5	0	8
II	2	0	1	8	8	0	13
III	3	0	1	8	2	0	11
IV	2	1	7	4	2	0	12
V	11	0	6	16	10	1	37
VI	10	3	6	3	0	8	21
VII	3[2]	0	0	1	1	0	4[2]
VIII	–	0	0	0	0	0	–
IX	10	6	1	2	0	0	14
X	2	1	0	2	5	0	7
TOTAL	44	11	25	47	33	9	127

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[1] The sum of these numbers is greater than the total number of facilities because more than one treatment/disposal option may be available at a facility.

[2] Some sanitary landfills may currently be handling hazardous waste. As in other Regions, these facilities are not included in the reported data for this table.

Source:

USEPA: Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment, SW-894; Prepared by Booz, Allen, and Hamilton; Putnam, Hayes, and Bartlett, Inc.; Washington, D.C., 1980.

XI-10 COST OF OFF-SITE HAZARDOUS WASTE DISPOSAL, 1980

Disposal Method	Cost[1] ($/wet kkg)
Landfill	
Wastes not acutely hazardous, including sludges	20-90
Highly toxic, explosive, or reactive wastes	100-400
Land Treatment	5-25
Incineration	
High BTU value, no acute hazard	50-300
Highly toxic, heavy metals	300-1000
Chemical Treatment	
Acids, alkalines	15-80
Cyanides, heavy metals, highly toxics	100-500
Resource Recovery	50-200
Deep-Well Injection	
Oily wastewaters	15-40
Dilute toxic rinse waters	50-100

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[1] Actual reported prices for treatment and disposal of hazardous waste, excluding transportation.

Source:

USEPA: Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment, SW-894; Prepared by Booz, Allen, and Hamilton; Putnam, Hayes, and Bartlett, Inc.; Washington, D.C., 1980.

B. HAZARDOUS WASTES: THE LAWS

Chapter 1

THE KEY ELEMENTS OF RCRA

Summary

- The Resource Conservation and Recovery Act of 1976 (RCRA) completely overhauled the federal Solid Waste Disposal Act.

- Subtitle C calls for comprehensive federal regulation of all hazardous waste. EPA must regulate generators and transporters of hazardous waste, and must issue permits to facilities that treat, store, or dispose of hazardous waste.

- All shipments of hazardous waste are made subject to a manifest tracking system.

- Subtitle D provides funds for state programs regulating the disposal of nonhazardous solid waste.

- RCRA gives EPA broad enforcement powers, including authority to respond to any "imminent and substantial endangerment" to health or the environment. It authorizes administrative orders, injunctive relief, civil fines, and criminal penalties.

* Reproduced with the permission of the copyright holder from Federal Regulation of Hazardous Wastes: A Guide to RCRA. Washington, Environmental Law Institute, 1982. p. 2-12.

The Resource Conservation and Recovery Act[1] has produced one of the most intricate and bewildering regulatory frameworks that exists in any area of federal law. To avoid becoming lost in its maze of details, it is essential first to understand the basic features of the program. A good place to begin is with a review of the statute.

One might expect this statute to be extremely complicated, perhaps akin to the mind-numbling incomprehensibility of the PSD provisions of the Clean Air Act or the tax-free corporate reorganization provisions of the Internal Revenue Code. Surprisingly, that is not the case. RCRA is relatively straightforward. It is written in English. It can be read and understood. It would be helpful to almost any person studying this program to start by reading the law itself.

In reviewing the statute, one must remember that its provisions give no suggestion of the awesome superstructure of regulations now built upon those provisions. What the statute does contain are the basic concepts which are carried out in, and dominate, the detailed regulations. Amidst these concepts are *the five major elements in the federal approach to hazardous waste management*, which are as follows:

(1) *federal classification of hazardous waste*;
(2) *cradle-to-grave manifest system*;
(3) *federal standards* for safeguards to be followed by generators, transporters, and facilities which treat, store, or dispose of hazardous waste;
(4) *enforcement* of federal standards for facilities *through a permitting program*; and
(5) *authorization of state programs* to operate in lieu of the federal program.

The Act directs the U.S. Environmental Protection Agency to promulgate regulations necessary to put the federal program into full effect.

Before discussing these key elements of RCRA, it is important to provide an operational perspective. RCRA concerns the handling of hazardous waste at currently operating (or future) facilities. It was designed in large part to plug a gap left by the Clean Air Act and Clean Water Act. Those statutes require industry to remove hazardous substances from their air emissions and their water discharges. Those statutes, however, could not assure that the ultimate disposition of waste materials would be environmentally sound. RCRA was intended to provide that assurance. RCRA does not, however, deal directly with abandoned sites or closed facilities where hazardous wastes have been handled or disposed of in the past. These situations are covered by the Comprehensive Environmental Response, Compensation, and Liability Act, commonly referred to as "Superfund," enacted by Congress in 1980. Finally, RCRA also does not concern hazardous substances which are within the productive streams of commerce, such as chemicals covered by the Toxic Substances Control Act, pesticides which are regulated under the Federal Insecticide, Fungicide and Rodenticide Act, or other hazardous products subject, for example, to the Hazardous Materials Transportation Act, and other various types of federal regulation. To repeat, *the focus of RCRA is on the handling of hazardous material which is generated as wastes from current industrial operations* not subject to regulation under the air and water pollution control programs.

With these brief comments, we may begin the review of the principal features and sections of RCRA. Although this review will concentrate on the statutory provisions, in some cases it will be helpful to round out the description by reference to the pertinent regulations.

Classification of Hazardous Waste

The threshold determination in the regulatory process is the characterization of the waste. The basic approach of the statute is to divide the regulation of wastes into two categories—hazardous wastes[2] and other solid wastes.[3] Because this is the building block upon which the entire structure is based, it is important to note the statutory language defining "hazardous waste" as:

> "a solid waste, or combination of solid wastes, which may, because of its quantity, concentration, or physical, chemical, or infectious characteristics . . . pose a substantial, present, or potential hazard . . . when improperly treated, stored, transported, or disposed of, or otherwise mismanaged."[4]

As this definition implies, *a waste must first be characterized as a "solid waste" before it can be classified as a hazardous waste.*[5] Curiously, however, in order to provide full coverage for the regulatory framework the term "solid waste" is defined by statute to include liquid, semi-solid, or contained gaseous materials if they are wastes.[6]

Section 3001 directs EPA to promulgate criteria for identifying and listing hazardous wastes. Pursuant to this mandate, *EPA has expressly listed a long series of industrial waste streams determined to be hazardous.*[7] *It has also established four basic criteria for the determination of hazardous wastes. These are ignitability, corrosivity, reactivity, and toxicity.* Any waste material which when tested meets one of these criteria will also be classified as a hazardous waste and must be handled pursuant to the hazardous waste regulations. In addition, however, both the statute and EPA's regulations have expressly excluded several major categories of substances from regulation.

It may be noted that although the practical needs of administering a hazardous waste program require a division of the universe of wastes into two categories—those that are hazardous and those that are not—this facile, two-category classification scheme oversimplifies the subtle complexities of reality. This very first conceptual formulation of the regulatory framework establishes the approach of lumping together into a single category a wide diversity of waste materials whose hazardous qualities differ profoundly in both nature and degree. The significance of that approach is intensified by the further language—also logical on its face—declaring waste materials to be hazardous if they pose a potential hazard when improperly handled. Since all manner of waste materials might present a hazard if mismanaged, this concept lends itself to establishing a very broad reach for the category of hazardous wastes. The consequences and implications of this fundamental concept will become more apparent as our review of the framework proceeds.

Cradle-to-Grave Manifest

The second basic concept underlying the federal hazardous waste program is the cradle-to-grave manifest system. *Any waste classified as hazardous becomes subject to a manifest system through which every load of hazardous waste can be tracked from its origin at the plant of the generator through the hands of each transporter to its ultimate disposition* at a treatment, storage, or disposal site.[8]

What this cradle-to-grave manifest system provides is more than merely an opportunity to track the movement of hazardous wastes through the chain of commerce to ultimate treatment or disposal. It provides also a mechanism through which ultimate accountability for an environmentally sound disposition of waste materials can be imposed upon the original generator of the waste. A clear purpose of the statute is to place that primary responsibility on the waste generators, an objective suggested both by a belief that in all fairness the generator of wastes should remain responsible for them and also by the practical realization that in numerous instances the generator would be bigger and more financially responsible than the transporters or disposers of the wastes.

The statute specifies that any generator that transports or offers for transport any hazardous waste must prepare a manifest.[9] The manifest must designate the facility that is permitted to handle the waste. The manifest must contain sufficient copies for each transporter and the designated facility, with an additional copy to be returned to the generator when the waste is delivered to the designated facility.[10] If the generator does not receive prompt return of its copy of the manifest, it must investigate and may need to notify the government.

A transporter may not accept a shipment of hazardous waste from a generator unless accompanied by a manifest.[11] Similarly, the designated facility may not accept a shipment of hazardous waste unless accompanied by a manifest.[12] In addition, the EPA regulations require the facility to note and report any discrepancy between the manifest and the waste shipment received.[13] In short, *the manifest system is intended to place a clear responsibility on each generator to determine the ultimate disposition of its wastes and to provide assurance that the wastes go where they are sent*. This manifest system is then backed up by further provisions to assure that the wastes are properly handled when they get there.

Generators

In addition to the manifest requirements, section 3002 provides for federal standards on generators with respect to a number of pretransport requirements. The most basic of these is that *it places responsibility on each generator to evaluate its wastes* (including testing) to determine whether they fall within the classifications of hazardous wastes requiring compliance with the entire federal regulatory program. In addition, other requirements under section 3002 cover packaging, labeling, and marking of waste containers used for transport.[14] Since the regulations promulgated by EPA pursuant to section 3002 expressly incorporate the same basic requirements imposed by the Department of Transportation, the additional regulatory burden is slight.[15]

A generator must also comply with specific recordkeeping and reporting requirements.[16] The EPA regulations require the generator to keep a copy of each manifest, signed and dated by the designated facility, for three years.[17]

In addition to the obligations imposed on generators as such, companies which generate hazardous waste may also be subject to other regulations, including particularly the standards and permitting requirements applicable to treatment, storage, and disposal facilities if the generators also conduct those operations.[18] As one important example, generators which store their wastes on-site for more than 90 days before shipping the wastes for off-site disposition will be deemed to operate a hazardous waste storage facility requiring a permit. It should also be noted that the regulations provide limited relief to certain small generators, subject to specified restrictions.[19]

Transporters

Section 3003 of the Act directs EPA to promulgate regulations applicable to transporters of hazardous waste.[20] Transporters are subject to the same recordkeeping requirements as generators in regard to manifests. Similarly, they are subject to Department of Transportation spill reporting regulations incorporated by reference in RCRA regulations. A transporter may only deliver hazardous wastes to a designated facility that holds a RCRA permit.[21] In addition, EPA regulations require transporters to take immediate action to protect human health and the environment in the event of a discharge during shipment.[22]

Treatment, Storage, and Disposal Facilities

Owners and operators of hazardous waste treatment, storage, and disposal facilities (TSDFs) are subject to far more extensive and complex regulations. The major focus of the federal program is the proper treatment, storage, and disposal of hazardous wastes. Section 3004 directs EPA to promulgate regulations necessary to protect human health and the environment.[23] These regulations impose direct federal controls on all permitted TSDFs and are explained in considerable detail in Chapter 7 below.

The effectiveness of the federal regulatory scheme rests on the combination of the manifest system and the regulation of TSDFs. The manifest system is designed to assure that no hazardous wastes can be disposed of anywhere other than at an approved TSDF. The section 3004 regulations then come into play to assure that the hazardous wastes will be handled at the TSDFs in an environmentally acceptable manner.

Section 3004 provides that the actual treatment, storage or disposal of any hazardous waste must be in accordance with "operating methods, techniques, and practices" approved by the Administrator, and that EPA shall promulgate regulations governing the "location, design and construction" of TSDFs.[24] These are the regulations that EPA has had the greatest difficulty in developing. The regulations for different types of facilities have come out in separate packages, with those covering land disposal facilities the last to arrive. These requirements are highly detailed and cover all facets of the operation.

The regulations require extensive groundwater monitoring to detect and evaluate any migration of contaminants from a facility. Where problems are found, permits issued to such facilities will require remedial action to treat or remove contaminated groundwater. The regulations also require that all new facilities must meet specified design standards. For example, all new landfills must be equipped with liners and leachate collection systems. Likewise, location requirements prohibit plant construction within a specified distance of geologic faults, in addition to stringent standards to prevent the wash-out of hazardous wastes by 100-year floods.[25]

Every TSDF is required to maintain records of all hazardous wastes that are transported to the facility for treatment, storage, or disposal.[26] Another important element of the federal plan is the required facility contingency plan. Each facility must develop a plan designed to protect human health and the environment by minimizing the potential for fires or unplanned releases.[27] The regulations also call for preparation of written closure and post-closure plans,[28] and establish financial responsibility requirements to assure funds to carry out these plans and to compensate third parties who have sustained injury due to operation of the facility.[29]

Permits

From an operating or administrative viewpoint, the heart of the federal program will be the permitting system. Under Section 3005, *all treatment, storage and disposal facilities handling hazardous wastes must obtain permits, and the permits will provide the principal mechanism through which the federal requirements will be made explicitly applicable to these individual facilities.*

The permit regulations establish the procedures, including a public hearing, for issuing an individual permit. The permit application must include information with respect to the "composition, quantities, and concentrations" of any hazardous waste to be handled at the site, in addition to extensive information with respect to the operations and controls involved.[30] A permit may be issued upon a determination by the Administrator that the facility will be in compliance with all requirements of the federal standards. Special permit conditions will be included to impose site-specific requirements, in addition to standard provisions requiring compliance with all applicable federal and state regulations. Violations of any permit conditions are subject to heavy federal enforcement sanctions.

The fact that thorough investigations and time-consuming proceedings would be required for issuance of each permit confronted Congress with an enormous transitional problem in implementing the statutory requirement that every TSDF must have received a permit to authorize its operation. It was obvious that issuance of permits to all existing hazardous waste facilities might require several years and individual facilities could not fairly be penalized for not having a permit until having been afforded a reasonable opportunity to obtain one. To provide an orderly transition in the introduction of permit requirements, Section 3005(e) provides for "*interim status*" for any facility that was in existence on November 19, 1980 if that facility complied with the notification requirements of Section 3010(a) and also submitted a timely application for a permit.[31]

As a result of delays in the promulgation of EPA's regulations to govern issuance of permits, the interim status provisions have assumed a greater importance than was originally anticipated by Congress. The regulations issued by EPA to implement the interim status program have filled the regulatory gap that would otherwise have existed until individual permits are issued by imposing *numerous requirements on facilities during the interim status period*. These include a full range of administrative and operational requirements, covering such items as ground water monitoring, contingency plans, closure and post-closure planning, financial responsibility, reporting, and personnel training.

There is, however, no interim status mechanism to cover *new facilities*. They *cannot operate until a permit has actually been issued*. This necessity to obtain a permit may present a substantial deterrent to construction of new facilities especially during the shakedown period of establishing the substantive requirements, procedural rules, and state agency programs for administration of the program.

State Hazardous Waste Programs

Another basic element of the program established by RCRA is the *anticipation that primary operating responsibility for issuance of permits and application of all regulatory requirements will be picked up by state programs* operating in compliance with general federal guidance.

Section 3006 directs EPA to promulgate guidelines to assist in the development of state programs.[32] A state may seek to administer its own hazardous waste program by submission of an application to the Administrator for approval. EPA has established a two-stage process for qualification of states to administer the program, including "interim authorization" and "final authorization." Moreover, EPA has also split the authorization process into separate parts covering different categories of facilities as the agency has promulgated permitting standards for such categories. As a result it is somewhat confusing to track the progress of state agencies in taking over RCRA responsibilities, but the trend is clearly in that direction.

The Administrator may refuse to authorize a state program if (1) it is not equivalent to the federal program; (2) it is not consistent with the federal or other state program; or (3) it does not provide adequate enforcement to assure compliance.[33] It is most important to note that *these tests of equivalence and consistency do not require the state programs to be identical to the EPA regulations*. There may be a number of significant differences. Moreover, section 3009 prohibits any state from applying any standards that are less stringent than corresponding federal standards, but that section explicitly preserves state authority to impose requirements which are more stringent.[34] These provisions may cause difficulties to companies operating in many states, both as a result of the differences between state requirements and especially during the transitional period while responsibilities may be shifting between EPA and the state agencies.

Until a state program is approved, a company must comply with both the state requirements and the federal requirements. Once authorized, however, a state program has the same force and effect as the federal program and in effect displaces the federal program.[36] The state may issue and enforce permits for the treatment, storage, or disposal of hazardous waste. If at any time, the state program fails to comply with the federal guidelines, the Administrator is authorized to withdraw authorization and re-establish a federal program.[36]

Section 3011 authorizes EPA to make grants to state agencies to assist in the development and implementation of state programs.[37] The authorized funds are to be allocated among the states on the basis of regulations promulgated by EPA. Grants may be made for state-authorized hazardous waste programs or programs to protect the public health and the environment from inactive facilities.[38]

Inspections

Section 3007 provides for access to hazardous waste facilities for the purpose of developing regulations and enforcing the provisions of Subtitle C.[39] A facility must furnish specific information and make records of the wastes handled available upon request by EPA or a designated state official. EPA or state officials, depending on the status of the state program, are authorized to enter any facility at a reasonable time to inspect records and obtain samples of any waste or containers holding waste.[40]

Any information obtained from an owner or operator is available to the public except upon a proper showing that public access would divulge trade secrets or other similar *confidential information* protected under section 1905 of Title 18 of the United States Code.[41] Any person who "knowingly or willfully" divulges protected information is subject to fines and imprisonment. In submitting information, the owner or operator must both designate the data it believes is entitled to protection and submit it separately.[42]

Federal Enforcement

Section 3008 provides *stringent federal enforcement powers* to back up RCRA requirements. It authorizes the Administrator to issue *compliance orders* or commence civil action in federal district court for appropriate relief. If a violation occurs within a state which has an authorized state program, the Administrator must give the state notice prior to issuing an order or commencing court action.[43] Failure to comply with an order is punishable by a civil fine of not more than $25,000 per day of noncompliance. The Administrator may also revoke or suspend a facility permit.

Section 3008 also includes *criminal penalties* for failure to comply with Subtitle C. This section makes it unlawful to knowingly transport any hazardous waste to a facility that does not have a permit or knowingly treat, store, or dispose of a hazardous waste without a permit or in knowing violation of a permit requirement.[44] It also prohibits destroying any records required by the Act or submitting false information on an application, manifest or other document required to be filed.[45]

The 1980 Amendments to RCRA added new and unusually severe sanctions for the *new felony offense of "knowing endangerment"*[46] This provision imposes substantial penalties on any person who, at the time of the offense, knowingly "places another person in imminent danger of death or serious bodily injury," if the conduct manifests an "unjustifiable and inexcusable disregard for human life," or manifests an "extreme indifference for human life." A conviction under the provision can result in a *fine up to $1,000,000* for a corporation, and of not more than $250,000, or imprisonment for five years, or both, for an individual.[47]

Statutory Amendments

When RCRA was enacted in 1976, it entirely revised and superseded the previous federal legislation concerning the control of waste material, the *Solid Waste Disposal Act* (SWDA). Technically RCRA was adopted as an amendment to the SWDA and therefore is properly referred to under that name, although it is perhaps more commonly referred to as RCRA.

The legislation was further altered in significant respects by the Solid Waste Disposal Act Amendments of 1980. Those amendments exempted a number of substances from regulation for specified periods.[48] They explicitly called for distinctions in control requirements between existing and new facilities.[49]

They also added to the statute section 3012, which requires an inventory of all hazardous waste sites within each state, and section 3013, which broadens EPA's authority to order or conduct investigations of hazardous waste sites, including inactive sites.[50]

The SWDA (or RCRA) has also been amended by other federal statutes, including the Used Oil Recycling Act of 1980. Moreover, as this report is being prepared active consideration is being given to still further proposed changes currently pending before Congress. Additional amendments therefore may well be enacted before the end of the 1982 Congressional Session, or otherwise they are likely to be reproposed when the next Congress convenes in 1983.

Subtitle D—State and Regional Solid Waste Plans

Although the hazardous waste regulations are fully contained in Subtitle C of RCRA, at least brief mention of Subtitle D is warranted regarding the regulations it establishes over nonhazardous wastes, especially since a number of important industrial waste streams have been excluded from the definition of hazardous wastes and therefore may be affected by these regulatory requirements. The objective of Subtitle D is to encourage development of methods of disposal of solid wastes that are both environmentally sound and contribute to the conservation of resources.[51] The nature of the federal approach to these concerns differs markedly, however, from the tight regulatory controls imposed over hazardous wastes. Subtitle D deals with nonhazardous wastes largely by providing federal technical and financial assistance to the states. Each state is called upon to develop a plan to implement general federal guidelines and to assume full responsibility for enforcement.[52]

The central regulatory feature of Subtitle D is the establishment of criteria for identifying facilities meeting acceptable environmental standards which are classified as "sanitary landfills" and those which do not and are classified as "open dumps".[53] Applying this basic division between acceptable and unacceptable facilities, *any facility that does not qualify as a sanitary landfill is automatically defined as an open dump*. The criteria established by EPA must at a minimum provide that a facility may only be classified as a sanitary landfill if "there is no reasonable probability of adverse effects on health or the environment from the disposal of solid wastes at such facility."[54]

The statute then directs that *all open dumps either must be closed or must be placed on an enforceable schedule* to achieve compliance with applicable regulations within five years.[55] To push this process forward, section 4005(b) requires EPA to publish an *inventory* of disposal facilities that are classified as open dumps.

The plans to be prepared by each state must identify the responsibilities of state, local and regional authorities for: (1) implementing the plan; (2) distributing federal funds; and (3) coordinating regional planning under the state program.[56] The plan must prohibit the establishment of new open dumps, contain requirements to close down or upgrade existing open dumps, and include regulations for resource conservation and proper waste disposal in sanitary landfills.[56] Once submitted, a state solid waste plan must be approved or disapproved by the Administrator within six months.[58] Development and implementation of state plans are eligible for federal financial assistance.

Conclusion

Although this summary has been designed to provide only a general introduction to the RCRA program, chiefly by reviewing the highlights of RCRA's statutory provisions, a more thorough examination of the program will reveal that there are no major features not contained in the statute and mentioned in this summary. As stated earlier, the legal framework provided by this statute is impressively straightforward. It is a much simpler law than companion federal environmental statutes such as the Clean Air Act or the Clean Water Act. One therefore is left to ponder two *intriguing questions*: *Why all the delay* in putting this legal framework into effect; and *why all the complexity* presented in the regulations? The answers cannot be discovered in the statute itself or in its legislative history. Instead we must look at the world of practical realities to which this legal framework was intended to apply. It is only by recognizing the unbounded diversity of the industrial operations, wastes, waste-handling practices, and other factual circumstances, that it is possible in any way to appreciate the difficulties encountered in implementing the mandate of RCRA. Before proceeding with a description of the legal requirements, therefore, we must pause for a brief, but extremely important, survey of these irrepressible facts.

SUPERFUND

A Legal Update

By JEFFREY TRAUBERMAN

Reacting to the growing public outcry over toxic substances pollution, on December 3, 1980, in the waning hours of the 96th Congress, the House of Representatives gave its approval to the Senate's recently scaled-down version of "Superfund" legislation (see box) One week later President Carter signed the bill into law.[1]

The new statute provides a relatively broad response and liability mechanism for dealing with toxic substances pollution and represents a significant improvement over the inchoate patchwork quilt of federal law previously applicable to releases of hazardous substances.[2] However, the law was forged amid the compromises struck during the legislative scramble for adjournment and is notable for their failure to make any provision for private recoveries for injuries caused by hazardous substances. In addition, unlike earlier legislative proposals,[3] the new law lacks provisions covering oil spills. Environmentalists and sympathetic legislators have vowed to continue the fight for a more comprehensive measure, although prospects for passage of such legislation in the new Congress appear dim [see "Congress and the Environment: What's Passed? What's Pending?" *Environment*, January/February 1981].

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The new law, formally called the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), applies to hazardous waste sites and other sources of toxic substances pollution. In essence, the law authorizes governmental responses to actual and threatened releases of hazardous substances. Those parties causing the release of such substances may then be held liable without regard to fault for certain governmental damages resulting from the release, including cleanup, removal, and resource restoration costs.

To ensure that such injuries are redressed, the law establishes a $1.6 billion Hazardous Substances Response Fund, to be financed jointly by industry and the federal government over the next five years. In those cases where the polluters are unknown, or are unable or unwilling to provide recompense, a claim for damages may be filed against the fund by the injured governmental party—federal or state. Payment of claims by the fund transfers to the fund the right of the claimant to sue the polluter. This makes it possible for fund representatives to attempt to recover the claim payments it has made from the party or parties responsible for the hazardous substance release.

Within this broad statutory outline, the new law establishes various procedures and principles governing response authority, liability, fund administration, and the filing of claims.

Response Authority

The Act provides the federal and state governments with a fairly sweeping mandate to mitigate and respond to pollution and requires the President to broaden the scope of the National Con-

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LEGISLATIVE HISTORY OF SUPERFUND

The 96th Congress considered more than 20 proposals involving compensation and liability for environmental pollution. However, only three of these—two on the House side and one in the Senate—were reported out of committee.

The surviving Senate bill, S.1480, established a $4 billion compensatory fund and contained relatively broad liability provisions, calling for strict, joint, and several liability among a wide range of potentially responsible parties. In addition, it covered private injuries and included provisions for the payment of medical expenses. At the time of the Senate's consideration of S.1480, however, the House of Representatives had already passed two more limited measures, H.R. 85 and H.R. 7020.

H.R. 85 was essentially limited to the recovery of certain governmental and private damages for spills of oil and designated hazardous materials in waters covered under the Federal Water Pollution Control Act. H.R. 7020 was a bill restricted to providing recompense to the government for cleanup, removal, and response costs for damages resulting from abandoned hazardous waste sites. Private recovery of damages was not available under H.R. 7020.

With legislative adjournment imminent, the Senate apparently realized the improbability of enacting very sweeping legislation during its lame duck session. Thus, a compromise bill was sponsored by Senators Randolph and Stafford from the Environment and Public-Works Committee. This bill, passed by the Senate on November 24, 1980, was the direct forerunner of the current law. After a series of stops and starts, the House of Representatives enacted the Senate's compromise bill into law on December 3, 1980.

tingency Plan for oil and hazardous materials spills originally developed under the Clean Water Act.[4]

Under CERCLA, the federal government must be notified "immediately" of specified releases of pollutants and hazardous substances.[5] Unless the President determines that pollution removal and remedial action will be conducted by the party responsible for the pollution, the President may take remedial action whenever:

- any hazardous substance is released or there is a substantial threat of such a release into the environment, or
- there is a release or substantial threat of release into the environment of any pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare.[6]

However, except in certain emergencies and in cases where the states are cooperating in alleviating the pollution, most of the President's actions are limited to a period of six months or to the expenditure of $1 million in response costs, whichever occurs first.[7]

In responding to such pollution incidents, the President can contract with states or political subdivisions of states to carry out the provisions of the Act. Contracts with private concerns to assist in cleanup are also envisioned under the Act. The President may delegate these and his other responsibilities and duties under the Act to the appropriate officials.[8]

Liability

Considerable controversy surrounded the evolution of the liability provisions of the new law. Under legislation originally considered by the Senate, owners and operators of polluting vessels or facilities as well as those engaged in the disposal, treatment, and generation of hazardous wastes were to be held jointly, severally, and strictly liable for certain pollution-related damages.[9] These provisions were intended "to induce potentially liable persons to voluntarily mitigate damages" and to prevent anyone from either "contracting away" responsibility for hazardous substances or alleging that third parties caused the pollution.[10]

However, largely because of industry objections,[11] particularly with respect to the liability of hazardous waste generators, specific references to joint and several liability were eventually dropped.[12] Strict liability was retained in the final measure,[13] but a defendant may assert as a defense that the damages complained of resulted from acts of war, acts of God, or acts of independent third parties where the defendant establishes that he has exercised due care with respect to that party and the alleged pollutant.[14] This latter provision allows generators, transporters, and disposers of hazardous wastes to avoid liability for damages resulting from the improper acts of certain other parties if they can demonstrate that they exercised due care. Note, however, that this provision does not apply to employees of the defendant, nor nor does it apply to most other parties if directly or indirectly related by contract to the defendant, as would ordinarily be the case between generators, transporters and disposers. Thus, this provision should not restrict those state courts that otherwise might impose joint and several liability on such parties.

The Act's liability provisions only apply in the event of a release of a designated hazardous substance. Compensable damages include governmental pollution removal costs, other necessary costs of responding to pollution incidents, and damages to natural resources.[15] The Act restablishes the following liability limits for each release or incident:

(1) for vessels carrying hazardous substances as cargo or residue, $300 per ton or $5,000,000, whichever is greater;

(2) for other vessels, $300 per gross ton or $5,000, whichever is greater;

(3) for motor vehicles, aircraft, pipelines, or rolling stock, $5,000,000 or whatever lesser amount the President may establish (but in no event less than $5 million or, for releases of hazardous substances into navigable waters, $8 million);

(4) for other facilities, the total costs of response plus $50,000,000 for statutorily compensable damages.[16]

Resource damages are paid generally to the United States and to the state in which the resources are located, owned, or managed. Liability for resource damages may not be imposed if such damages occurred wholly prior to the passage of the Act.[17]

The liability limits do not apply in cases where the polluter fails to cooperate in cleanup efforts, where known violations of safety and other regulations are the primary cause of injury, or where the pollution results from willful negligence or misconduct. In such instances, unlimited liability may be imposed for response costs and other governmental damages. Triple damages may be assessed as a punitive measure for failure to obey a Presidential cleanup order.[18]

The Act also contains certain potentially significant qualifications to and exemptions from liability. It does not cover damages from "federally permitted releases" of pollutants,[19] or from the application of a registered pesticide; nor does it cover damages resulting from activities which were previously determined in an environmental impact statement to involve an "irreversible and irretrievable" commitment of natural resources.[20] In addition, a special $200 million Post Closure Fund established by the Act assumes liability for hazardous waste sites that have been issued permits under the Resource Conservation and Recovery Act (RCRA) and that have been closed in compliance with such permits.[21] The money for this fund is to come from a tax on the receipt of hazardous wastes at facilities that have been issued such permits or that have been accorded interim status under RCRA.[22]

Claims against the Fund

Under CERCLA, $1.38 billion of the $1.6 billion Hazardous Substances Response Fund is to be financed by a tax on oil, specified organic chemicals, and certain heavy metals; the remaining funding will come from government appropriations. The act provides for the promulgation of regulations requiring polluters to notify potential injured parties of the release of hazardous substances. Claims against the fund may be made for the following items:

(1) payment of governmental response costs incurred under the Act's response authority provisions;

(2) payment of other necessary response costs under the National Contingency Plan established under section 311 of the Clean Water Act and to be revised under CERCLA;

(3) payment of claims asserted and compensable but unsatisfied under section 311 of the Clean Water Act; and

(4) payment for certain other purposes, including monitoring resource losses; restoring, replacing, rehabilitating, or acquiring the substantial equivalent of damaged resources; conducting epidemological studies; and purchasing cleanup equipment.[23] Claims may be filed up to three years after discovery of the damage or the date of the Act's enactment, whichever is later.

Environmentalists and sympathetic legislators have vowed to continue the fight for a more comprehensive toxics cleanup bill, but prospects for passage of such legislation in the new Congress appear dim.

Claims for resource damages may be asserted only for those resources belonging to, managed, or protected by state or federal governments. Funds are not available for resource injuries occurring wholly before the enactment of CERCLA, or for claims resulting from multiple source, long-term exposures to ambient concentrations of air pollutants.[24]

Federal claims are filed by the President as trustee for the damaged natural resources. In evaluating claims the President or his delegate is also responsible for an initial determination of resource damages. Since the President can be both a claimant and the initial arbiter of a claim's valuation and validity, the Act seems to create the potential for an apparent conflict of interest.[25]

Before claims can be asserted against the fund they must be presented to the owner, operator, guarantor, or other known, potentially liable party. Specific regulations governing claims procedures are to be issued by the President. If the claim has not been satisfied within 60 days, the claimant has the option of initiating an action in court against the potentially liable party, or presenting the claim to the fund. If the claim is presented to the fund the President must attempt to arrange a settlement between the claimant and the alleged polluter. When the potentially liable party is unknown or cannot be determined, the claimant and the President are encouraged to arrive at a settlement of the claim against the fund.[26]

If a settlement is not reached within 45 days, the President may either make an award or decline to make an award. If the President makes an award and the claimant is dissatisfied with the amount, he may appeal the President's determination to the federal courts. If the President declines to make an award, appeals to arbitrators and the courts may follow. Implementation of the claims procedures is intended to be accomplished by using the facilities of private resource and claims adjusting organizations; only in special circumstances may federal personnel be used for this purpose.[27]

Once a claim is paid, the fund or the party paying the claim acquires the legal rights of the claimant.[28] This entitles them to seek recovery of their claim payments from the culpable parties in another proceeding. Thus, the Act is intended to redress injuries and, where possible, to encourage the eventual assignment of individual liability for damages. These principles are potentially valuable both in deterring pollution and in preventing excessive depletion of fund resources.[29]

Industry was probably pleased to have restricted the scope of the Superfund bill. Environmentalists may have felt that it would be easier to expand the coverage of an existing law rather than start again from the beginning.

Additional Provisions

The Act has several other important provisions. It provides for broad federal emergency authority to abate imminent and substantial dangers to the public health and welfare.[30] It includes "sunset" language, which specifies that the fund's authority to collect taxes will expire December 30, 1985, unless Congress acts to extend it.[31] Another provision of the Act gives Congress 90 days in which to veto any proposed rule or regulation for implementing the law. This veto can take the form of a concurrent resolution adopted by both Houses of Congress, or a resolution adopted by one House within 60 days and not acted upon by the other House during the succeeding 30 days.[32]

Various technical and legal studies are authorized by the Act, including a study of the adequacy of the legal remedies currently available for compensating the victims of exposure to toxic wastes. In addition, the law establishes an Agency for Toxic Substances and Disease Registry to improve data collection and otherwise assist in matters concerning toxic substances and human health.[33]

While the Act does not attempt to preempt state law regarding hazardous substances releases, no contributions to other funds may be required of anyone in order to pay claims for damages already covered under the Act. Multiple recoveries for the same injuries are also prohibited.[34]

Prospects for Implementation

EPA's efforts to implement CERCLA will be critical to the reduction of environmental contamination from hazardous substances releases. Recent reports suggest that the Reagan administration may be reluctant to implement Superfund.[35] However, even if EPA chooses to administer the Act efficiently and effectively, difficult regulatory decisions lie ahead. Because of limitations on the money and resources available to the Fund, it is essential that EPA establish rational priorities for dealing with such releases. The attempt to improve risk assessments and to obtain better information about the location, magnitude, and severity of incidents of toxic substances pollution should be given a high priority in EPA's development of regulatory strategies under the Act.

One possibility is that the government, in order to conserve fund resources, may focus its cleanup efforts on those hazardous waste releases where the responsible parties are clearly ascertainable, so that fund expenditures can be recovered. Thus, it is conceivable that the Act will not be fully utilized to clean up the true "orphan" waste sites.

EPA's implementation of the Act must also reflect a sensitivity to certain nonquantitative factors involved, including public skepticism about past governmental efforts to address the problem of hazardous substances pollution. Furthermore, since the Act places heavy emphasis on collaboration between the federal and state government, EPA may need to foster an improved spirit of intergovernmental cooperation in carrying out its mandate under Superfund.

During the early stages of debate, Superfund started out as an ambitious attempt to use liability as a complement to regulatory intervention in decreasing the risks from toxic substances. By making it easier to hold polluters liable for the damages they cause, it was hoped that not only would injuries be redressed but that an added measure of pollution deterrence would be achieved. The current Comprehensive Environmental Response, Compensation and Liability Act does not abandon these principles, but it incorporates them in a law of more limited scope and impact. By restricting the coverage of the law to *governmental* cleanup, resource restoration, and pollution response costs, Congress has indicated its reluctance to modify legal principles traditionally relegated to state control. Thus, private citizens injured by toxic substances must litigate their claims in a state court according to the common law rules which apply in that particular jurisdiction. Whether barriers tor recovery under state law often prevent adequate redress for such injuries, however, has been the subject of considerable debate.[36]

In addition, the decision to eliminate coverage for oil spills is noteworthy.

since this has long been recognized as an area in which uniform federal legislation is needed. While this omission caused concern among many legislators, resolution of this issue will have to await action by the current Congress.

The legislative decisions that determined the eventual contours of Superfund were, of course, born of political and practical necessity. First, intense time pressures during the rush toward adjournment played a prominent role in the debate. Second, media attention directed to the problem of toxic substances pollution had heightened public awareness, resulting literally in an outcry for legislative action. Lending a note of urgency to the debate, these two factors provided an important backdrop to the entire Superfund controversy.

Given this background, industry was probably pleased to have restricted the scope and coverage of the Senate's original bill.[37] Environmentalists, for their part, were certainly conscious of an incoming Congress and Administration that purported to be less sensitive to their concerns. Thus, it may be that the environmental community felt it would be easier to expand the scope and coverage of existing legislation to include oil spills and the right of individuals to seek redress of damages through the fund rather than to initiate future legislative efforts without any law in existence at all. With the anticipated emphasis of the new, incoming Congress and President on limiting federal intervention in a variety of fields, however, environmentalists will almost certainly face an uphill battle in achieving these deferred goals.

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NOTES

1. Pub.L. No. 96-510 (hereinafter referred to as "the Act"). For a copy of the text of the law see Cong. Rec. H11773-H11802 (December 3, 1980).

2. The Federal Water Pollution Control Act, 33 U. S. C. A. 1251, 1321 (oil and hazardous substances spills), the Outer Continental Shelf Lands Act, 43 U. S. C. A. 1331 (oil spills) the Deepwater Port Act, 33 U. S. C. A. 1501 et. seq. (oil spills), and the Trans-Alaska Pipeline Authorization Act, 43 U. S. C. A. 1651 (oil spills and other harmful activities along the pipeline). J. Trauberman, "Compensating Victims of Toxic Substances Pollution: An Analysis of Existing Federal Statutes," 5 Harv. Env. L. R. 1 (1981).

3. See, e.g., H.R. 29, 85, 3441, S. 684, 1341, 96th Cong. 2d Sess.

4. Act §104, 105. The new plan must specify "procedures, techniques, materials, equipment, and methods" for addressing releases of hazardous substances. Id.

5. Id., §103. "Release" is broadly defined in the Act at §101(22), but excludes those exposures resulting from specified nuclear materials, workplace emissions, most engine exhausts and fertilizer applications. Also, notification is not required for a "federally permitted release " (see note 19 below) or for releases of less than a certain amount of a hazardous substance. Such "reportable quantities" must be determined by EPA, although the Act fails to guide the agency by specifying the time period over which such a release can occur before notification is necessary. In addition to the notification required when a hazardous substance is released, the Act also includes provisions requiring present and former waste facility operators and certain waste transporters to notify EPA of the existence of hazardous waste sites that have not received permits or interim status recognition under the Resource Conservation and Recovery Act (RCRA). Act, §103(c).

6. Id., §104.

7. Id., §104(b), (c). The Act does distinguish between remedial actions, Id., §101(24), and response, Id., §101(25). Response is a broader term than remedial action and is defined to include remedial action. Remedial actions are those specific steps "consistent with permanent remedy taken instead of or in addition to removal." Examples of remedial action listed in the Act include storage, confinement, neutralization, and recycling of hazardous substances.

8. Id., §104(d), (f), 111(f), 115.

9. S.1480 §4(a), 96th Cong. 2d Sess. (1980).

10. U.S. Senate Rep. No. 96-848 (1980), p. 31.

11. See, e.g., U.S. Senate, "The Environmental Emergency Response Act," Hearing Before The Committee on Finance, 96th Cong. 2d Sess. (1980), pp. 207-208.

12. Although specific reference to joint and several liability was not included in the legislation, it is possible that state courts will still impose joint and several liability on statutorily covered parties for so-called "indivisible" injuries. See, e.g., Cong. Rec. H11787-11789 (December 3, 1980), Statement and submission of Congressman James J. Florio.

13. Act, §107(a). Although the term "strict liability" is not used in the law, the Act does not provide for general defenses to liability based on the exercise of due care. Thus, like §311 of the Clean Water Act, strict liability is essentially imposed on parties deemed to have caused pollution. See, e.g., Cong. Rec., note 12 above. Note also, "Liability Without Fault Under The Federal Water Pollution Control Act," Nat. Res. J. 19 (1979): 687.

14. Act, §107(b). Liability under the Act may not be avoided through the use of indemnification, hold harmless, or similar agreements. Id., §107(e). In addition, the Act's liability and other major provisions are applicable against the federal government. Id., §107(g).

15. Act, §107(a) (4) (A-C).

16. Id. §107(c) (1) (A-D).

17. Id., §107(f).

18. Id., §107(c) (2), (3).

19. The definition of "federally permitted releases" is quite complex and seems unclear in its application to certain state permits issued pursuant to federal laws. Id., §101(10).

20. Id., §107(j), (i), (f).

21. Id., §107(k), 111(j).

22. Id., §231(a), 232. "Facility" is defined in the Act at §101(9).

23. Id., §111(a) (1)-(4), (b), (c).

24. Id., §111(b), (4), (i).

25. Id., §111 (h), (i).

26. Id., §112(a), (b).

27. Id., §112 (b) (2), (3), (4). Jurisdiction to review the award is vested in the federal district court for the district where "the arbitral hearing took place." While the President's determination is not actually an "arbitral hearing" as that term is envisioned under the Act, it would seem that the district courts for the District of Columbia would have jurisdiction to review the determination of the President or his delegatee.

28. Id., §112(c) (1), (2). Upon request of the President, the Attorney General is required to take legal action to recover claim payments made by the fund from the party responsible for the hazardous substance release. In attempting to recover such amounts, the Attorney General is not limited to invoking the provisions of CERCLA, but may base his action on any law under which the polluter could be held liable to the fund or the compensated claimant. Id., §112(c) (3).

29. If a harmed party makes a claim under the Act, he does not thereby waive his right to attempt to recover damages for injuries not covered by the Act. Id., §112(e).

30. Id., §106.

31. Id., §303.

32. Id., §305.

33. Id., §104(i).

34. Id., §114(a), (b), (c).

35. See, "*EPA's* Role in Superfund May Be in Danger," Chemical and Engineering News, Feb. 9, 1981, p. 8.

36. See, e.g., U.S. Senate, 96th Cong., 2d Sess. Six Case Studies of Compensation for Toxic Substances Pollution, June 1980: U.S. Senate, 96th Cong., 2d Sess. The Environmental Emergency Response Act, 1980, pp. 243-248, 669-679. See also W. Pfennigstorf, "E "Environment, Damages, and Compensation," Amer. Bar Fdn. Res. J. 2 (1979): 347, 444-448; Toxic Torts (Rheingold, Landau, Canavan, eds.), 1979.

37. Even under the compromise legislation enacted, however, there is concern in industry that insurance will be unavailable to cover the increased potential liability for environmental damages.

environment

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Superfund: How it will work, what it will cost

Last Thursday, President Carter signed the Comprehensive Environmental Response, Compensation, and Liability Act of 1980—the superfund. It ended a three-year, often-bitter battle that only a month ago, by the reckoning of chemical industry lobbyists, had left the superfund bill a dead issue, and in the final stages had divided the industry. Now that the bill has become law, chemical companies are faced with figuring out how superfund will work, and toting up their costs.

Beginning in April, companies will pay taxes to the Treasury Dept. on major chemical feedstocks and certain petroleum products. Other parts of the act, notably revision of the National Contingency Plan originally established by Section 311 of the Federal Water Pollution Control Act, will take effect by mid-June.

Major provisions of the new law include:

- Establishment of a $1.6-billion fund to clean up deposits and spills of hazardous subetances and to fund remedial action when hazardous-material releases are threatened.
- Establishment of a tax schedule on 42 designated hazardous chemicals and petroleum products to provide 87.5% of the funds. The rest of the funds will come from general federal revenues. The chemicals and petroleum products are considered the building blocks of most hazardous substances. The tax terminates Sept. 30, 1985, but could end earlier if unobligated balances in the fund exceed stipulated amounts.
- Establishment of a Post-Closure Tax and Trust Fund of $200 million to pay costs of monitoring, care and maintenance of hazardous-waste disposal sites after they have been shut down. The post-closure fund will be financed by a $2.13/ton (dry weight) tax on hazardous wastes delivered to a disposal facility; the tax will be levied on the owners or the operators of the waste facilities.
- Revision of the National Contingency Plan for removal of oil and hazardous substances. The revision will include a national hazardous-substance response plan, including establishment of priorities to determine which disposal sites will be remedied first, and means of assuring that remedial action is cost-effective.
- Establishment of liability, basically by adopting the scheme of liability equivalent to that of Section 311 of the Federal Water Pollution Control Act. In general, carriers, disposal facility operators, and others involved in the disposal or transporting process of hazardous substances are liable for all costs of removal or remedial action incurred by the government, including response costs, and for damages to natural resources.
- Establishment by the Public Health Service of an agency for toxic substances

The superfund tax:

Chemical	Tax rate $/ton	Price	Tax as percent of price	Production*
Acetylene	$4.87	25-26¢/lb.	0.94-0.97%	350,000 lb.
Benzene	4.87	$1.70/gal.	1.05	1.5 billion gal.
Butane	4.87	80¢/gal.	1.43	25-30 million bbl (1978)
Butylene	4.87	70¢/gal.	1.74	3.4 billion lb.
Butadiene	4.87	32¢/lb.	0.76	2.8 billion lb.
Ethylene	4.87	23.5¢/lb.	1.04	27 billion lb.
Methane[1]	3.44	$1.48/thousand cu.ft.	4.92	567 billion cu.ft. (natural gas, 1978)
Naphthalene	4.87	22-30¢/lb.[2]	0.81-1.11	163 million lb.[3]
Propylene	4.87	18-18.5¢/lb.	1.32-1.35	14 billion lb.
Toluene	4.87	$1.40/gal.	1.28	1.5 billion gal.
Xylene	4.87	$1.45/gal.	1.22	850 million gal.
Ammonia	2.64	$155/ton	1.70	2.5 million tons
Antimony	4.45	$1.70/lb.	0.13	14,800 tons (primary); 25,000 tons (secondary); 21,000 tons (imports)
Antimony trioxide	3.75	$1.50-1.80/lb.	0.10-0.13	20,576 tons (1977)
Arsenic	4.45	$1.90/lb.	0.12	Less than 360,000 lb./year; 200,000 tons (imports)
Arsenic trioxide	3.41	25¢/lb.	0.68	Less than 100,000 tons; 12,000 tons (imports)
Barium sulfide	2.30	$115-150/ton	1.53-2.00	53,000 tons (1977)
Bromine	4.45	28¢/lb.	0.79	500,000 lb. (1979); 1,000 lb. (1979, imports); 140,000 lb. (1979, exports)
Cadmium	4.45	$2.50/lb.	0.09	1,590 metric tons; 2,610 m.t. (imports); 270 m.t. (exports)
Chlorine	2.70	$145/ton	1.86	10.9 million m.t. (1979)
Chromium	4.45	Not available		800,000 tons (1979 consumption)
Chromite	1.52	$56/m.t.	2.99	1.5 million tons (1979, imports)
Potassium dichromate	1.69	48¢/lb.	0.18	Not available
Sodium dichromate	1.87	37¢/lb.	0.25	168,000 tons (including sodium chromate)

and disease registry, with cooperation of the states. It will include a registry of persons exposed to toxic substances, listings of areas closed to the public because of contamination by toxic substances and an inventory of research, literature and studies on health effects of toxic substances.

The act sets financial responsibility standards for cargo carriers and for operators of disposal facilities. It calls for a report to Congress on the feasibility of establishing a system of private insurance for post-closure financial responsibility for waste-disposal facilities and establishes penalties for various types of violations. Penalties include: up to $10,000 or up to one year in jail for certain violations regarding failure to notify the government of the existence of a site; $10,000/day for failure to prove financial responsibility; and punitive damages of up to three times the costs of a cleanup operation, in some cases.

In addition, chemical companies will have to contend with state superfunds, now being implemented (*p. 41*). And they may face a battle in the next Congress over personal-liability provisions, which were not included in the federal supefund law.

Mixed reaction. Opinion is still divided on the merits of the superfund (*CW, Dec. 3, p. 16*). The industry strenuously opposed its early versions. But some companies are "relatively pleased" with the final version.

Chemical feedstock taxes are nominal in many cases. Ethylene, for example, will carry a tax that amounts to about 1% of its present 23.5¢/lb. selling price. The tax on methane, however, is an exception. It amounts to 4.92% of the estimated average 1980 selling price of $1.49/Mcf (*table*). But even that may not be as bad as it seems. As a chemical feedstock, methane is used mainly for the production of ammonia and methanol. Roughly 90% of that methane is used for ammonia, about 80% of which is used for fertilizer production. And the fertilizer industry has won an important exemption: Substances used to make fertilizer, e.g., nitric acid., sulfuric acid, ammonia, and methane, will not be taxed.

Other important exemptions are fuel uses of methane and butane, sulfuric acid produced as a by-product of air-pollution control, and chemicals derived from coal. In addition, crude oil used for extracting oil or natural gas on the premises where the crude oil is produced escapes tax.

Still, many companies object to the fund in general and, in particular, to the taxes imposed for financing the cleanup. They say that some firms are more at fault than others for the vast number of disposal sites that are hazardous. And the attorney for one company asks why ethylene, for instance, should be taxed when the material, as used in the industry, is relatively nonhazardous.

Poor drafting of the act is a complaint in which many join, including John Blackburn, marine transport associate for the American Petroleum Institute. "It's just cobbled together", he says.

Another industry representative expresses concern about superfund language in dealing with the reportable quantities necessary to trigger an emergency response. The Environmental Protection Agency's administrator of the act will have the authority to establish "one single quantity" as the reportable amount for an emergency response—and that could be as little as one pound. In addition, superfund does not establish a time period for the release of the reportable quantity.

And it is not just industry that is worried about the new law. How the administrator will use the broad discretionary powers conferred by the law is a concern of the Sierra Club. The environmentalist group also wonders how the incoming Reagan Administration will

how the 42 chemicals stack up

Chemical	Tax rate $/ton	Price	Tax as percent of price	Production*
Cobalt	4.45	$25/lb.	0.01	1,000 tons (1979, secondary); 9,500 tons (imports)
Cupric sulfate	1.87	$45.20/cwt (·5H$_2$O)	0.21	35,000 m.t. (as ·5H$_2$O)
Cupric oxide	3.59	$1.60/lb.	0.11	Not available
Cuprous oxide	3.97	$1.71/lb.	0.12	Not available
Hydrochloric acid	0.29	$55-62/ton (20° Bé, 31.4%)	0.15-0.17	2.96 million tons (100%)
Hydrogen fluoride	4.23	66¢/lb. (anhydrous)	0.33	254,000 tons (1978); 86,000 tons (imports); 175,960 tons (anhydride)
Lead oxide	4.14	63.5¢/lb. (litharge) 54¢/lb. (red lead)	0.33 0.38	119,000 m.t. (1977) 18,000 m.t. (1977)
Mercury	4.45	$400/flask (76 lb.)	0.04	26,000 flasks; 16,000 secondary; 36,000 imports
Nickel	4.45	$2.20/lb.	0.10	37,000 tons (1979, primary); 47,000 tons (secondary); 195,000 tons (imports)
Phosphorus	4.45	$2.17/lb.	0.10	418,000 m.t. (1979)
Stannous chloride	2.85	$6.43/lb.	0.02	Not available[4]
Stannic chloride	2.12	$4.31/lb.	0.025	Not available[4]
Zinc chloride	2.22	$15.25/cwt	0.73	13,000 tons of zinc condensed as as zinc chloride (1977)
Zinc sulfate	1.90	$20/cwt	0.48	17,200 tons (1978)
Potassium hydroxide	0.22	$11/cwt (45% basis)	0.04	264,000 tons (1979)
Sodium hydroxide	0.28	$220-260/ton (50%)	0.05-0.06	13 million tons (1979; all forms)
Sulfuric acid	0.26	$39-84/ton (100% basis)	0.31-0.67	37.4 million m.t. (1979)
Nitric acid	0.24	$4.80-6.25/cwt (58.5-68%)	0.13-0.18	8.56 million tons (1979)

*Estimates for 1980 unless otherwise stated. [1] Feedstock use only; average 1980 price is shown. [2] From petroleum. [3] Nonfertilizer use only. [4] 5,700 m.t./year of tin are used in chemicals. Sources: U.S. Interior Dept., SRI International, DeWitt & Co., CW estimates.

Representative Florio: Worried about sites.

handle superfund. Possible personnel cutbacks by a new, economy-minded Administration could severely hamper enforcement of the act, says Robert Graziano, vice-president for business development at O.H. Materials, an emergency and cleanup response firm. O.H. Materials in general stands to gain from the act which could greatly expand the market for its services.

On the Hill, Representative James Florio (D., N.J.) is concerned that the law's provisions for post-closure funds could result in the government having to shoulder the burden of monitoring dump sites closed in perpetuity. The post-closure liability fund initially will have only $200 million available.

And Marc Tipermas, chief of EPA's superfund office, speculates that the $1.6 billion superfund won't be big enough. Superfund will finance the cleanup of 100-300 abandoned dump sites, "a fraction of the overall problem," he says. As a result, he adds, states will have to pick up a large share of the cost of cleaning up abandoned dump sites. Yet, states are looking to superfund to help them finance their own cleanups.

Liability implications. Much of the chemical industry's hostility toward earlier versions of superfund centered on the sticky question of legal liability. The Carter Administration had sought "strict, joint and several liability." And the original Senate bill would have allowed victims of injury by toxic wastes direct access to federal courts to seek damages. The final bill makes no mention of strict, joint and several liability, and does not provide victims with direct access to federal courts—an apparent victory for the chemical industry.

Strict liability would have made most parties involved in the disposal process—generators, disposers, haulers—open to damage suits regardless of negligence or use of contemporary waste disposal standards— even in a case where, without a firm's knowledge, waste was dumped on a road side, says Robert Zener, an attorney with the Washington, D.C., law firm of Pepper, Hamilton & Scheetz, which specializes in hazardous-waste disposal law.

Joint and several liability would have made any participant liable in an action, regardless of the extent of participation. If, for instance, 50 firms used a site and only one drum carried a firm's label, that firm could be sued for damages.

But the chemical industry may not be home free on strict, joint and several liability in superfund. Anthony Roisman, the attorney in charge of the Justice Dept.'s hazardous-waste section, points out that the superfund legislation essentially adopted liability equivalent to that contained in Section 311 of the Federal Water Pollution Control Act. Liability under Section 311 "has fairly uniformly been determined as strict liability," says Roisman. And adds EPA's Tipermas, "If I have to rely on the existing liability standard, Section 311 is as good as any."

Senator Randolph: Compromise co-author.

Similarly, lack of mention of joint and several liability in superfund does not necessarily mean that type of liability is a dead issue. Roisman notes that suits brought under Section 311 have generally involved owners and operators of hazardous-waste sites; questions concerning joint and several liability involving generators have mainly yet to be considered by the courts. Moreover, Roisman notes that some common law has established joint and several liability for hazardous-waste handling. And Section 302(d) of superfund says "nothing in this Act shall effect or modify in any way the obligations or liabilities under other Federal or State law, including common law, with respect to releases of hazardous substances." The same section also says that nothing in the act shall be construed as making the doctrine of strict liability inapplicable.

As superfund now stands, people injured as a result of hazardous-waste disposal must seek redress under common law in state courts, a procedure often prohibitively expensive for individuals. Many superfund supporters are unhappy with that situation, including Senator George Mitchell (D., Me.), a member of the Senate Environment and Public Works Committee. He wrote in *The New York Times*, last week that he voted reluctantly for superfund because it "made property more important than persons"—a reference to the provision that allows the government to sue for damages to natural resources.

The Sierra Club will push hard in the next Congress for "something on behalf of the victims," says Blake Early, Washington lobbyist for the organization. And superfund, itself, calls for a number of studies, including one dealing with the adequacy of existing common law and statutory remedies to provide redress for people harmed by the release of hazardous substances.

Contingency plan. The chemical industry's most immediate concerns with superfund focus on revision of the National Contingency Plan. The plan was originally set up under Section 311 of the Federal Water Pollution Control Act to deal with spills of oil and hazardous materials. Spills of hazardous substances will now be handled under superfund. It adds hazardous-waste disposal facilities to the plan, says Bonnie Casper, who is leading the EPA team that will rewrite the plan. And the new law covers discharges to groundwater, land and air, and will broaden the liability of carriers.

Previously, hazardous-substance coverage was limited to the 258 substances designated under Section 311. Superfund adds substances covered under the Clean Air Act, the Resource Conservation and Recovery Act, the Toxic Substances Control Act, and the Solid Waste Disposal Act. EPA now has authority to relocate people and fund relocation if necessary.

The Chemical Manufacturers Assn.'s

Senator Stafford: Cost-benefits are vital.

concern with the new contingency plan is underscored by the colloquy of Senator Jesse Helms (R., N.C.) with Senator Robert Stafford (R., Vt.), which was inserted in the Congressional Record to provide guidance in future court cases as to Congressional intent. Helms was one of the few supporters of the chemical industry's position in the Senate debate.

As Helms sees it, the plan is the principal instrument for governing superfund's expenditures. Helms' major concern is that the plan's cost-benefit analysis will be applied to "determine whether and when action should be taken to remove hazardous substances or to remedy or otherwise respond to releases." Senator Stafford, a co-author with Senator Jennings Randolph (D., W.Va.) of the compromise senate bill, also sees consideration of cost-benefit relationships of a particular response action as an "essential part of the National Contingency Plan."

Efforts will also be made next year by some members of Congress to put oil-spill cleanup under superfund. Funds available under Section 311 of the Federal Water Pollution Control Act would be inadequate for a major oil spill, which could cost $30-50 million, says EPA's Tipermas. It is another indication that the superfund battle just ended may be far from the last one fought. □

States are planning to draw on the superfund

A number of states have established their own cleanup funds and are getting ready to tap money available from the federal superfund. State environmental agencies are expected to move swiftly because of the large number of abandoned disposal sites, particularly in heavily industrialized states.

In New Jersey, for example, a 1977 law covering cleanup of oil and hazardous-substance spills was amended this year to include dumps abandoned before 1977. Taxes on oil and hazardous substances are now generating $1 million/month for cleanup programs, says Paul A. Giardina, director of the hazard management program for the state's Dept. of Environmental Protection. Since January, the state has spent over $20 million and cleaned up 16 sites. It will apply for federal assistance as soon as superfund money becomes available. The goal: funding cleanup of 5 to 10 additional sites.

No more ceiling. A $25-million ceiling on the Illinois hazardous-waste fund established in 1979 was removed this year by the state legislature. So far no money has been disbursed, in part because of uncertainty as to whether the money must be spent only for sites permitted by the state, or can be used for other sites as well. For finances, Illinois levies a 1¢/gal. tax on liquid wastes and a $2.02/cu yd tax on solid waste.

Ohio created a state superfund two months ago (*CW, Oct. 22, p. 20*) that will be financed by a 4% fee on the amount charged by disposal firms for their services. In addition, Ohio will collect a flat $1,000-5,000 annual fee from companies disposing of hazardous wastes on their own sites. Incineration would not be taxed, although the state's Environmental Protection Agency may ask the legislature to close this loophole.

Earlier this year, Louisiana amended a 1979 waste-control act to establish three separate funds for cleaning up abandoned sites, post-closure site maintenance and monitoring, and emergency response. Money for the closure fund will be raised by a tax on the disposal industry. Money for the other funds will come from grants, donations, legislative appropriations, fines and legal judgments.

Florida's Dept. of Environmental Regulation is devising implementation rules for a new fund law that became effective in October. The $10-million fund will be financed mainly from a 1% tax, effective Oct. 1, 1981, on the costs of treating, storing or disposing of hazardous waste. The tax will climb annually to a maximum of 4%, says state attorney Douglas MacLaughlin. No tax will be levied on waste treated at state-certified facilities because the state wants to encourage treatment rather than disposal. Reasons: threatened ground water contamination and scarcity of good disposal sites. The new law complements a 1974 fund law dealing with oil, gasoline, chlorine, ammonia and pesticides, which are taxed at the rate of 2¢/bbl.

In the future. Texas has had a spill-prevention- and -control act on the books for several years, but the law covers only coastal counties and does not embrace disposal sites. Next year, the state legislature will consider a bill that would impose a maximum 50¢/ton tax on industrial solid-waste disposal.

If states move to obtain federal funds, and estimates of future demand for site cleanup prove correct, the $1.6-billion federal superfund may only serve as a start. Any further effort to expand federal funding could well rekindle the superfund debate. □

(Excerpted from: U.S. Library of Congress. Congressional Research Service. Superfund: hazardous waste cleanup. Washington, U.S. Library of Congress, 1983. 18 p.)

EPA's Implementation of CERCLA

Critics (including a number of Members of Congress, some of whom were involved with enactment of CERCLA) have charged that the Superfund law has been implemented too slowly and with insufficient vigor. The National Contingency Plan (NCP), which Congress directed EPA to revise by June 9, 1981, was not finalized until July 16, 1982 (and then only under court order). The delay was due to rewriting of the document to reflect the new Administration's views on Federal regulation and on the Federal-State relationship. As revised and published, the NCP dropped specific cleanup standards, strongly encouraged States to assume responsibility, and emphasized employing the least costly cleanup alternative. Critics charged that this led to a situation in which it was likely that some sites would be only partially cleaned up or not cleaned up at all, if the State decided not to proceed or if the remedy was too expensive when balanced against other demands on the fund. The agency responded that the plan provided flexibility needed to deal with many different types of sites, that there is insufficient knowledge of cleanup methods to set national standards, and that the fund is not large and must be spent carefully. The Chemical Manufacturers Association concurred in this view.

A year and a half after the law was passed, only about 10 of the worst sites in the country were being cleaned up using Superfund monies, according to one report (see Hanson article in reference section). While inspections and feasibility studies were underway at a number of other sites, this activity was not the rapid response envisioned by some authors of the law, and led to accusations that the Superfund monies were being used to help balance the budget, and that the lack of expenditures was an indication of a lack of commitment to the goal of cleaning up dump sites. Critics also complained that the agency was applying too strict standards in judging whether to respond.

An EPA press release of Dec. 20, 1982, accompanying the announcement of the 418 sites on the National Priority List, summarized the agency's accomplishments as follows:

> . . . since enactment of Superfund, EPA has initiated action at 112 sites while States have addressed another 29

> without Federal assistance. The program has financed 98 removal actions at a cost of $29.5 million, and 70 remedial (long-term) actions at a cost of $87.7 million. [EPA Administrator Anne (Gorsuch) Burford] said cooperative agreements affecting $35.5 million worth of work at 36 sites have been signed with 19 States, and contracts worth $22 million and involving 29 sites have been written with 16 States. As of the end of FY 1982, $265 million had been appropriated by the Congress for Superfund and $221 million had been spent.

Figures from the U.S. Treasury Department showed that only $87.6 million had been spent by the end of FY82. Part of the difficulty is that EPA's announcements have used certain budgetary terms interchangeably, sometimes saying "expended" when "obligated" or "committed" was meant. Whether deliberate or not, the loose phrasing caused confusion and fueled suspicions that the agency was trying to appear more vigorous than was the case.

Also pertinent to Superfund's slow start was the arrival of the new Administration in January 1981, which resulted in several internal EPA reorganizations. An enforcement philosophy of nonconfrontational voluntary compliance was adopted, as opposed to one emphasizing litigation. In terms of CERCLA, this meant increased negotiating with firms over how much of the cleanup costs they would pay, rather than going to court. This course was justified as being cheaper in the long run, given the high cost of litigation, and as being a faster process, permitting actual cleanup to begin sooner. Critics pointed out that the law permitted cleanup to begin even before the question of who should pay how much was decided, and they seized upon several settlements that appeared to favor industry, as evidence that the new EPA leadership was more concerned with businesses' well-being than with health and environmental protection. Often cited was the dump in Seymour, Indiana, where 24 companies were allowed to settle in October 1982 for $7.7 million, although it was estimated that total cleanup would cost $30 million. Later, about 175 additional companies settled for $3.5 million; 150 other companies that dumped there have not yet reached agreement and may face litigation.

This was the background that led the House Public Works and Transportation Subcommittee on Investigations and Oversight to subpoena a number of documents relating to the administration of the Superfund law. At the President's direction, EPA Administrator Anne (Gorsuch) Burford refused to turn over those Superfund-related documents found to be "enforcement sensitive," particularly those that revealed the agency's strategy in ongoing civil and criminal prosecutions. On Dec. 16, 1982, the House found her in contempt of Congress. Rather than proceeding under its inherent contempt power, the House referred the matter to the Justice Department pursuant to 2 U.S.C. sec. 194.

The Justice Department refused to prosecute her, however, and instead sought a court ruling declaring the House action unconstitutional as an infringement on executive privilege. On Feb. 3, 1983, the U.S. District Court for the District of Columbia dismissed the suit and urged the parties to find a compromise. An agreement was reached on Feb. 18 that allowed the subcommittee full access to the contested files, while preserving the claim to executive privilege by establishing detailed procedures for protecting those files.

In the meantime, however, a number of actions and allegations raised additional questions about how well the program was being run. (For amplification of the various charges, responses, and denials, see citations to Environment Reporter in the reference section.)

-- The President, on Feb. 7, dismissed Assistant EPA Administrator Rita Lavelle, chief of the hazardous waste management program, at the request of Mrs. (Gorsuch) Burford, who said she had lost confidence in Lavelle. Five of Lavelle's top aides were also fired.

-- Charges of political favoritism were made regarding the release of cleanup money and the prosecution of offenders.

-- It was reported that some of the subpoenaed papers may have been shredded by EPA.

-- It appeared that EPA officials with conflicts of interest in some Superfund cases continued to take part in decisions even after having formally removed themselves.

-- Suspicions were voiced that Lavelle had given perjured testimony to Congress. The investigation was dropped when she was fired, but she was once again suspected of perjury when she testified in a later hearing, after her departure from EPA.

-- Inspector General Matthew Novick alleged that $53 million of the Superfund may have been spent for purposes unrelated to the program; a week later, on Feb. 23, he was fired. A GAO investigation found that Novick directed a secretary to spend 10-1/2 hours typing personal items on Government time; GAO found no evidence that he had improperly used his Government driver or helped a friend get a job, charges which had also been made against him.

-- It was charged that James Sanderson, who worked for over a year as a consultant to Administrator (Gorsuch) Burford, participated in agency decisions affecting his private legal clients; further, he may have charged those clients for time for which he was also paid by EPA.

-- The Labor Department found that an employee who had criticized agency hazardous waste policy had been illegally harrassed. After initially intending to appeal the ruling, EPA settled with the employee on Feb. 14, 1983, the day the appelate administrative law hearing was to have begun; he then turned over to the Justice Department and to Congress documents in his case that he claimed showed "criminal wrongdoing [by] . . . the White House."

On Mar. 9, 1983, Anne Burford resigned. She was replaced by William D. Ruckelshaus, who was confirmed in a 97-0 vote by the Senate on May 17 and was sworn in the following day. On June 23, 1983, the House Public Works and Transportation Committee voted to lift the contempt citation against Burford.

Two directors of the hazardous waste program told the Senate Environment and Public Works Committee on April 8 that Burford and Lavelle slowed Superfund expenditures to give the impression that the program would not need an extension of its taxing mechanism when it expired in 1965. Gene Lucero and William Hedeman said that their recommendations on ways of overcoming States' difficulties in raising their 10% of the cost of cleanup, as required by CERCLA, were rejected by Burford. Hedeman also testified that Lavelle ordered an inventory of the 15,000 abandoned waste sites that have been reported to EPA "to verify her view" that many of them required no action. She was against expanding the program, he said. Only about 170 sites will be cleaned up with the $1.6 billion authorized for the fund, according to Hedeman. Lucero said additional delays were due to Burford's failure to define the situations under which emergency action could be taken, and Lavelle's orders to reassess the risks posed by certain chemicals because she mistrusted EPA's data. (See Environment Reporter, Apr. 15, 1983: 2307-2308.)

A report requested before her departure by Burford of EPA's Office of Management Systems and Evaluation was released in May 1983 and seemed to corroborate the charges of mismanagement and deliberately slow implementation. Among the report's conclusions was the finding that the "agency never mobilized its full resources to implement the program in a coordinated way." Attempts by regional EPA offices to move aggressively in cleanup actions were thwarted by concern at headquarters that the fund be carefully used, resulting in "bureaucratic stalemate." Among the report's recommendations were that emphasis be shifted from remedial cleanup to emergency surface cleanup in light of the finding that about half (later changed to 100 sites) of the 419 NPL sites pose a threat of fire or explosion; that the distinction between immediate and planned removals be eliminated; and that the requirement for 10% State cost-sharing be deferred or ended. (See Environment Reporter, May 13, 1983: 52-53.)

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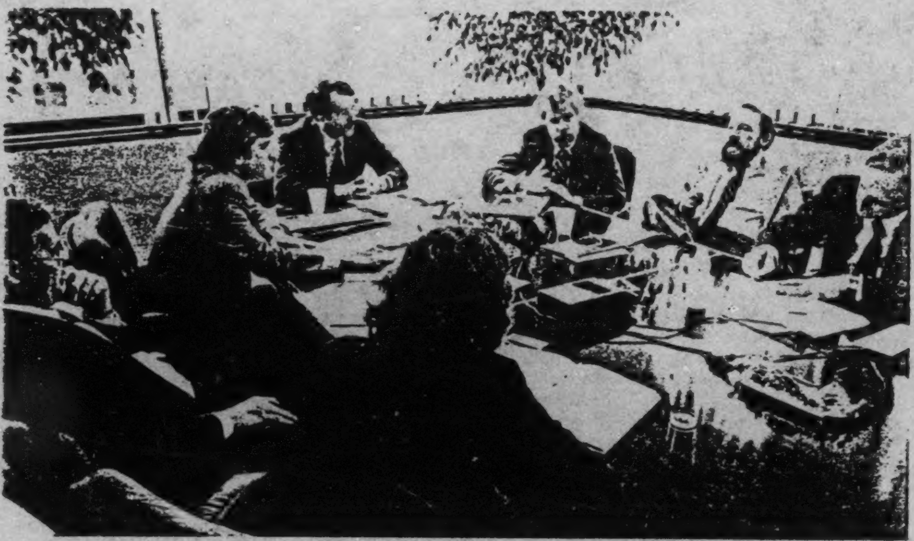

Six Superfund experts—all lawyers—address the rebuilding of the program in the wake of this past winter's problems at EPA.
(All photos by Barry Baron, Photo-Optik, Washington, D.C.)

Superfund-How to Rebuild a Badly Damaged Program?

In the wake of the controversies that have beseiged EPA, the Superfund program—more than other EPA programs and more than the agency overall—virtually has been brought to its knees. Not long ago, most observers were predicting lots of Superfund cleanup settlements would be announced over coming months. Few make that prediction now.

How serious is the damage to Superfund? What should be done now to restore the program? What is the future of Superfund now that the dust is settling and the agency, under Administrator Bill Ruckelshaus, is beginning to repair the damage? Those questions were put to a panel of experts representing diverse interests in the Superfund debate:

- **Colburn T. (Coke) Cherney**, EPA Assistant General Counsel for Superfund;
- **William Eichbaum**, Assistant Secretary for Environmental Programs, Maryland Department of Health and Mental Hygiene;
- **Khristine L. Hall**, Attorney with the Environmental Defense Fund;
- **James A. Rogers**, Partner, Skadden, Arps, Slate, Meagher & Flom;
- **Kirk K. Sniff**, EPA Acting Associate Enforcement Counsel for Waste Enforcement; and
- **David B. Weinberg**, Partner, Wald, Harkrader & Ross.

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Hall: From my perspective, the damage to Superfund began long before the last couple of months with a series of policy decisions, ad hoc decisions, actually at the initiation of this Administration, that have gradually been implemented and embroidered upon. We view the last two months as merely the public appearance of those very bad decisions. The damage began much earlier than just a couple of months ago.

I think there was a very early decision, for instance, to "conserve the fund"—to spend as little money as possible from the fund so that maybe at some point in the future, in 1984, when EPA is supposed to go back to Congress to report on whether another Superfund authorization is needed, they'd be able to say, "We didn't even need the $1.6 billion and we don't need another reauthorization of Superfund."

That whole philosophy of conserving the fund meant that EPA tried to cut corners whenever possible—tried not to spend money, put a lot of emphasis on negotiated settlements at *all* costs, tried not to spend money on the health studies that were mandated. That's one effect. Also I think there were some early decisions to try to downplay some of the health problems that might emerge from Superfund sites. Those decisions, I think, were what finally resulted in some of the political uproar that has occurred in the last couple of months.

Cherney: Certainly, all of this negative attention hasn't been pleasant. It has been very disruptive to the program, I hope temporarily.

If there has been damage, I hope that all of the attention will ultimately turn out to be an opportunity to re-examine what Superfund has been and what it ought to be, and an opportunity to improve the program. Without agreeing or disagreeing with Khris's comments, I think often we forget how long it takes to get a new program off the ground. Many of you were around when the Clean Air Act and Clean Water Act were enacted. Those programs didn't get off and running in a year or two. There were court-ordered deadlines and a lot of problems in fully implementing those programs. Hopefully, this is one of the learning experiences this young program is going through, and, as I say, it'll be a positive experience in the long run.

Eichbaum: I might just comment that I think there were problems in Superfund, as Khris has suggested, prior to the last couple of months. I think many of those problems were associated with the difficulties of getting a very large program started in a very short timeframe. They may have been associated with a desire to preserve funds.

I think they were also just associated with a sense of not quite knowing which way to go. In Maryland, we've had a little success in cleaning up a few sites and I think that was largely because we pressed EPA very, very hard—"We want these sites cleaned up, and we know how we want them cleaned up, and we know there are mechanisms that can be used. Now come on and do it." I think that that kind of *push* resulted in some cleanup. I'm very concerned, given what I think were problems that existed before the political events of the last couple months, that the current reaction goes to the *legitimate* historical problems that ought to be addressed and be worried about. However, I fear that the fanfare of the last couple of months may result in a Superfund that is so accreted with attention and concern and detailed scrutiny, and perhaps legislative attention, that we'll

REPRINTS

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never be able to do anything. We will even clean up fewer sites over the next two years than we did over the last two years. I think that's a very real danger.

Rogers: I think the program has suffered *enormous* damage, and I think it's going to be many years before it will recover the type of broad-based citizen/corporate respect and trust that it really needs to be successful.

I think there are two Superfund programs. One is the enormous public works program that essentially involves the government's going in and cleaning up the site. Closely related is the enforcement and the compliance program—the actions against the generators, the transporters at these sites—and the voluntary compliance which follows along from an effective enforcement program.

James Rogers of Skadden Arps

I sense almost a breakdown in the basic American trust in "the system," with respect to the latter Superfund program. This is the same trust that is the basis for our voluntary income tax system and the basis for just about everything we do in this country. I don't think I'm exaggerating. I sense from the people I talk to (most of whom don't live in Washington, D.C.) there is such widespread cynicism and lack of confidence in the EPA administration of Superfund now that it will take a long time before EPA will be able to convince people that difficult, honest policy decisions are somehow not "political." Those people that don't live here haven't followed all the details of these stories. But there's a deep general concern over EPA's administration of the hazardous waste laws. They see in their local newspapers memoranda of a conversation at the White House about a "sweetheart deal." They hear about some company's getting what appears to be special benefits and another company's being given the brunt of a cleanup. There is just a general sense that something was very wrong, and that Ms. Lavelle in particular had turned an enormously important legal program into a political game, a political campaign.

I think that type of distrust and cynicism is going to take a long time to overcome. I think it's going to damage the process of negotiation which has to go on in these major sites if you're going to avoid national litigation and having hundreds of lawyers litigating the bigger cases for years.

Eichbaum: Are you suggesting that the credibility of the program has been most severely damaged in the industrial sector? I still sense there is a great demand on the citizen side for this program to move forward and for projects to be listed, sites to be listed, and people to come out and study and get them cleaned up.

Rogers: I'm not saying that the corporate managers have changed their views toward cleaning up the environment or are any less concerned about doing a responsible job.

What I'm saying is that the process of communication, the trust one places in the government, has suffered a terrible blow. I could sit here for hours citing specific examples where the people in EPA regional offices with whom we're dealing are terrified to carry a settlement the next step—terrified about making a commitment on what level of trichlorethylene should be allowed in the remaining groundwater or soil. And the people who do want to get on with resolving their problems, who do want to clear up their footnotes on their SEC statements, who do want to avoid paying outside legal costs—they are totally frustrated right now. And in the cases I've got, the delicate negotiation process has come to a dead halt, with one exception.

If I may digress for a moment, I think the problem with the Superfund program at EPA emanates from a much larger problem. That is, that EPA is the most powerful regulatory agency in the government and it has not been treated accordingly. It hasn't been treated like the Antitrust Division; it hasn't been treated like the Securities and Exchange Commission. I submit that if Rita Lavelle had been nominated to be Assistant Attorney General for Antitrust, she would have been laughed out of town, and so would the President. I suggest that the Superfund program alone has more legal ramifications, more intracacies, and more day-to-day impact in this country than virtually every other regulatory agency, and that it deserves the type of regulatory stability, nonpolitical rhetoric, careful lawyering, careful scientific research, that a program of that size mandates—and it hasn't been getting it.

Hall: This public credibility issue, I think, is a fundamental problem with the whole of the agency right now and its a fundamental problem with Superfund in particular. I think it's also one of the avenues of repair for Superfund. EPA has got to stop treating the public like the enemy, which has been the case for the last two years in particular with the Superfund program. The negotiated settlements have taken place without public participation, even when the public has requested it.

Weinberg: I think Jim's point that there are two aspects to this program is worth keeping in mind, particularly with regard to what Khris just said. That is, there is a clean-up element and there is an enforcement element.

I don't disagree that the program has been done substantial damage. But it is clear that there were some things that would have led to delays in this program in *any* event. With regard, for example, to the clean-up side of the program, there are substantial technical questions as to what cleanup means when you get past the surface removal of drums. I think, there inevitably would have been some delays in the program as the agency, with or without cooperation from industry, tried to come to grips with, "What do you do in the face of a potential groundwater contamination?" So there would have been a slow down at some point in any event.

Hall: I thought EPA could have helped itself by defining some of those things more in the National Contingency Plan.

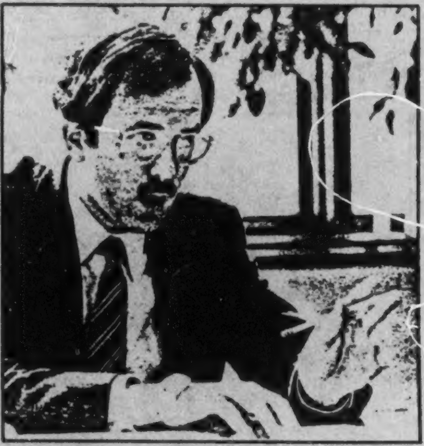
Weinberg: I'm not going to digress onto that issue at this point.

On the enforcement side, there inevitably would have been some delays because much of the enforcement strategy, the negotiation strategy, reflected uncertainties as to the law. And as negotiated solutions looked less attractive to the potentially liable parties, there would have been a natural tendency on their part to stop entering into settlements.

I look, for example, at the way the Chem-Dyne matter appears to be playing out. The partial settlement agreed to in that case by many companies was expected to defer litigation for some time but it doesn't now look as if parties are avoiding litigation simply because they settled with the agency. So there also would have been a delay on the enforcement/settlement side while the law develops further on some of the intracacies of these issues.

To go back for a second to another area that I think would have caused a delay in cleanups: the 10 percent and 50 percent requirements that are in this statute are very *real* limitations, I think, on government expenditures. Until those matters are addressed again by Congress, one way or the other, it in fact is not entirely fair to blame EPA for the failure to spend money.

In short, I don't disagree with those who say that there's been some injury—and some substantial injury—to the program. And I agree with Jim, from the standpoint of one who represents private parties on these matters, that the possibility of negotiation at this point, even as to those companies which are inclined to see the settlement as attractive, has been frustrated enormously, because no one on the regulatory side appears willing to make the kinds of hard decisions that have to be reflected in any negotiated solution. But I don't think that it's fair to simply say that the difficulties that this program faces now are solely the result of the political chaos that's been surrounding the agency for the last couple months.



David B. Weinberg of Wald, Harkrader & Ross

Sniff: I'd like to address the compliance and enforcement program. I agree that there have been some disruptions, and I think we're running a very real risk of paralysis in the negotiation of settlements. Part of that is due, I think, as you suggest, to the evolution of the program: early settlements, early negotiations, were site-specific, were ad hoc, and without a whole lot of guidance from either experience or legal decisions.

I think there's a very clear need at this point for a coherent strategy for approaching enforcement negotiations. I think it's going to be a tough job because we are obviously under a magnifying glass at this point. Every settlement, every negotiation, is going to be subject to a great deal of scrutiny. But I think that has positive aspects as well. I think it will require us to approach this whole issue in a more coherent fashion than in the past.

I think we're going to see some very real shifts in the nature of the enforcement program. We are going to see more Section 107 cost-recovery actions, and the 106/7003-type actions are going to essentially arise, I believe, in cases where the Fund cannot move, such as those where a state is unable to meet the match requirement of

Section 104(c). It's going to be very difficult to negotiate the major multiple-party cases. I do think, though, that those cases are still a minority of the cleanups we have out there. Most of the cleanups involve 20 or fewer responsible parties, and those cases are still manageable. But the Chem-Dynes and the Seymours, those kinds of settlements, those kinds of sites, are going to be very difficult to deal with over the next year or so.

Ward: I'd like to make sure I understand that. Is that as a direct result of the problems of the past or because there are fewer multi-generator sites, as you said? And I'd like to know also if everybody else agrees that there's going to be fewer, or it's a long time, before we'll see more multi-generator settlements?

Sniff: Well, I think these settlements, these cases, are so complex anyway that they're very difficult to settle, even without the kind of tension that's brought to bear on the program now. Obviously, the agency has already given signals that we have a presumption against voluntary agreements, consent orders, arrangements of that nature, and we are going to be looking for involvement of the courts, or at least the sanction of the courts through consent decrees. That has advantages and disadvantages. Advantages in the sense that it accords at least some opportunity for public participation, a point that Khris has made. There are many responsible parties who will not find that particular option very attractive.

Rogers: I believe that that is a major statement. We're shifting completely now from the injunctive actions to cost recovery actions. That means we will go at least a year, maybe more, in which the government initiates long-term expensive cleanups. And during that hiatus there will be few major settlements. Apparently, one of the major elements coming out of the uproar recently has been a reluctance to settle any case that does not incorporate a clear understanding of total groundwater and soil contamination cleanup costs. And those are really the gut policy issues which we have got to come to grips with in this program. If you're going to wait to find out how 14,000 drums of chemicals precisely affected the environment, and find out with the type of confidence that will allow you to go up before certain congressmen and answer all the questions they may ask—it seems to me you're talking about a couple of years before we will have big settlements. It means that the potentially responsible parties are going to be sitting on the sidelines wondering what's going to happen to them, wondering how expensive this EPA cleanup operation is going to be, wondering whether there have been proper clean-up techniques applied.

I think that thrusts all of us into a whole different set of issues—of what role these potentially responsible parties—who presumably will have received their notice letters and other formal communications from EPA—will have in all of this? Are they going to be afforded rights to come in and protest certain clean-up techniques? Are they going to be afforded the opportunity to come in and say, "You shouldn't be cleaning up toluene to 50 ppm in a desert environment. You can leave it there at 500 ppm." All of these are very tough issues. EPA may find itself shifting from injunctive litigation (RCRA Section 7003 and CERCLA Section 106) to some form of declaratory action over the propriety of cleanup programs. The point is, there may well still be early litigation even if the agency decides to clean up first and seek restitution later.

Eichbaum: Well I think what it's driven by, Jim, is the desire to get some sites cleaned up and worry about responsibility and the paying by a potential responsible private party later. And from my perspective at the state level—I don't know what the public's perspective is—I think there's a lot of merit to that proposal. What I see is endless study, endless dancing on the head of a pin, and no action.

Hall: From our perspective, that's also very healthy. We feel that that's basically what Superfund was meant to be—a mechanism for clean-up as quickly as possible and then worry about who's responsible at a later point. Negotiated settlements are fine, but they've also got to be undertaken with certain understandings of what the process is about and what the consequences are. I think those have been missing.

Cherney: I certainly agree with Khris that one of the major purposes of Superfund is to use fund monies where you can't get a site cleaned up quickly through Section 7003 or other enforcement-type mechanisms. In response to Jim's remarks, Kirk did not suggest a 100-percent, 180-degree change, but rather a shift in focus. And certainly we'll have to work out where the potentially responsible parties fit into this. Jim suggested that they may be sitting on the sidelines. I think we have to remember that one of the reasons for the shift toward more court sanction decrees is that responsible parties have not come forward voluntarily as often as had been expected. And therefore we're shifting to this because we apparently *do* need firm action to get these sites cleaned up. Maybe there will be some uncertainty among your industrial clients as to what their new role will be, but the role under the current situation has not been one that they have readily accepted. I think this shift is a natural outcome and is due in part to the inadequate response of responsible parties.

Sniff: I might add that I think we're moving in that direction in any event because of a recognition of the expenses and difficulties of these major negotiated settlements. I also do not want to suggest that there won't be 106 actions—there will be 106 actions. But I do see a shift more towards the cost recovery.

Weinberg: But the implication of what Jim has said, I think, is that from the potentially responsible parties' standpoint there now are a series of additional decision-making points that must be monitored, and that's where the focus of attention is going to move.

It is my view that most of the negotiated solutions have turned on whether those who settled thought they could assist the public interest by paying for environmental protection, rather than enriching their lawyers. These are enormously complicated cases, and settlement often reflected a cost-benefit analysis by the company: Should we simply litigate for a number of years, at some substantial cost and with no certainty of success, or can we contribute up front to a reasonable cleanup?

But if managers will face litigation costs somewhere along the line, regardless of their willingness to settle on some limited basis, they must look at all of their potential opportunities to protect their company. And so we're going to have questions raised when sites are listed on the National Priority List, about the reviewability of those decisions. There are already some lawsuits pending in that regard. I'm confident there are going to be more which will have some effect of slowing down cleanup, and further confusing the process.

Khris Hall of the Environmental Defense Fund

There also are going to be questions raised, when the agency believes that it has identified the appropriate solution, as to whether or not there is an opportunity for judicial review at that time. I understand it is the agency's position that NEPA requirements are met by virtue of the fact that there will be some informal opportunity for public review of the agency's proposed solution. That certainly implies the same sort of judicial review opportunities that would exist in the case when an environmental impact statement is considered unsatisfactory. So there may be more litigation at that stage in the process.

My guess would be that one of the policy decisions that has to be made early on, if the strategy Kirk suggests is to be followed, is whether in fact in many cases the agency wants to preserve the opportunity to go after remote, not readily identifiable, responsible parties. If that is the case, and if you do send the notice letters to the type of people who have been receiving them—a source of a handful of drums that went to a major site, people whose only known connection with a site is that they appear on a list of customers—you are buying an additional set of interests that inevitably are going to confuse and delay the process.

Furthermore, as much as I respect Khris's view that the purpose of the statute is to quickly clean up, and I agree with that, one of the things you'd have to face if you are looking down the road at holding generators responsible, is the problem of proof that you'd have five years down the road when you litigate that case: the chain of custody on the analyses, the degree of analyses that one has to undertake to show where various materials come from, and so forth.

Assistant Secretary William Eichbaum of Maryland

Eichbaum: But isn't one of the real fundamental issues whether we de-couple the cleanup from the liability question? Because it seems to me that as long as the two are tied and there's a financial stake, the process is going to work very, very slowly. It seems to me that the public interest is first cleanup, particularly for historical sites, and second, liability for something which you were not liable for when you did it as opposed to now having been made *perhaps* liable. I'm not sure that the public interest cares *that much* about making whole these dollars. I think this may be an area where changes in the statute have to take place. Without that kind of a shift—either by breaking classes of sites or by splitting money between the states and the federal government and allowing states to have a different kind of process which could work much more effectively and efficiently and quickly, and respond to problems rather than just have more litigation, I don't see that we could move forward.

Rogers: I agree with you completely, and I think you suffer from having too much experience in the environmental area. [laughter]

Eichbaum: I agree.

Hall: That may be a common problem of all of us actually. [laughter]

Rogers: Are you going to be able to sit in front of a group of United States congressmen and be able to convince them that they should allow the agency to forego taking legal action against polluters?

Eichbaum: Well that's really not what I said. I think what I was speaking to in the first instance was the *public* expectation, and I think that the public is more interested in getting the sites cleaned up than they are in delaying that process in the expectation that somebody will pay for that eventually. And I think I can sit and say that with a lot of folks in Baltimore, a lot of folks in Cecil County, and they go for it. Now I agree, translating that into national political acceptance at the other end of Pennsylvania Avenue may be a slightly more difficult problem and *will be* an especially different problem in the climate we have right now. Which is why I said that I'm very pessimistic about ever coming out of the woods.

Rogers: I have a question as a followup to what you've been saying and what Kirk's been saying about cleaning up now and worrying about recovering later. As federal and state officials, do you think it is possible that we could arrive at a policy that would allow a company who is, let's say a 10 percent contributor to a site by volume under the government's calculations, to contribute 10 percent of the costs of cleanup and get out of the case now and forever, rather than for possibly several years wondering and waiting, and talking to its lawyers about what's going on and what is happening? Or does that do so much violence to these concepts of joint and several liability that that is totally unacceptable?

Eichbaum: Well, I'll answer the question from a policy perspective and not a legal perspective. I don't see any reason why you couldn't do that at all.

Sniff: Let me address the question. I believe that we as an agency are going to be addressing sites as an organic whole. I think it will be very difficult in that we will not be amenable to partial, fair-share buy-outs. We are looking and I think we will press more than we have in the past, for 100 percent at sites. That may mean that some potentially responsible parties have to pay a premium, but we are going to be looking at the site as a whole.

Eichbaum: But if I can interrupt. I mean I would agree. You've got to look at a site as a whole from a clean-up perspective. But from a liability perspective, in order to not delay that clean-up process—why as a matter of policy, if we all agree that cleanup is the first priority, couldn't you at least entertain a scheme of reimbursing the public coffers in some vaguely appropriate way—Jim's suggestion?

Sniff: When I talk about the buy-out, I'm really talking about the front-end. We may be *more* willing to entertain some of these partial offers in a 107 context. But what we are looking for in the 106 context is all the money that it will take to clean up that site according to our studies—or for the parties to do it themselves.

Weinberg: In the 106 context you've got a different ball game in the sense that you are going to have a relatively compact administrative or judicial proceeding in which there will be some basis for determining who ultimately is going to have what percentage of the share of the cost. You may be able to get that done at the front-end in some of those cases. But in a lot of cases you won't be able to succeed, simply because the proofs won't be available until the clean-up is done. Those cases will not be substantially different from cost-recovery type actions.

Furthermore, I don't think there's any realistic basis to expect that any substantial number of sites are going to be able to be dealt with through 106 actions. The resources aren't available. If you used every U.S. attorney in the country to bring those actions for the next two years, you still would get only a limited number of sites.

The point that I fully agree with is that the key to being able to quickly spend the money in a way that deals with the environmental problem is to recognize up front that there has to be some divorce of enforcement questions from clean-up questions. Unless people are able to make that distinction, there inevitably are going to be further delays, and the program is going to be tied up. I also think it's going to be politically very, very difficult to make those kinds of decisions, because I envision it the same way that Jim does—someone from the agency being forced to explain to Congress why he's letting some alleged major polluter off the hook simply in order to cleanup the site more quickly.

Cherney: The comments of the last several minutes really have pointed out one of the core problems the agency has. As Bill says, the public expectation—the public desire—is to have the sites cleaned up quickly. And the fact of the matter is that we don't have the money to do that responsibly and yet clean up all the sites. It wouldn't be politically feasible or responsible policy to go out there and clean up all these sites if there are potentially responsible parties who ought to pay for it under the liability provisions of the statute.

As long as we have this dilemma, where the public expectation is rapid clean-up and yet there is a responsibility on the part of the agency to make sure those dollars go as far as they can, we've got a real dilemma. I think it's only theoretical and philosophical to talk about separating enforcement and clean-up in any significant way, because there never will be enough money to cover all these sites simply through funding.

Hall: The liability portion of the statute is important. And that's why there was such a big fight over it when Superfund was passed, and a lot of us participated in it. But I truly think it was Congress's second interest. The first interest was to make sure that the sites were cleaned up and if it was possible to recover, then recover.

A second approach to the problem that Coke has just raised is for EPA to bite the bullet and acknowledge that $1.6 billion was, as many people in Congress knew when the statute was passed in 1980, not going to be sufficient and acknowledge that Superfund is going to have to be reauthorized in 1985 for a fairly good-sized sum.

EPA Superfund Attorney Coke Cherney

Eichbaum: Number one, you may have Superfund last longer and need more money collected. Number two, I'm not sure, if you look at the world of 418 priority sites, I'm not sure that the way that list was put together necessarily says those are the sites we really have to deal with. I think there's a question there that we can put to the side. But I think there are two other issues that make this situation even more severe.

One is that, because of the litigation and the liability issue, we are spending time and money on studies to defend the decision and presumably whatever other reasons there are. That's wasting clean-up money in many ways. It's also again taking an incredible amount of time. We feel, looking at the sites we've got in Maryland, that is a problem.

Secondly, again I suspect, perhaps because of the conserving of the fund and because of the potential liability of the private sector, the cheapest option is the one that these studies are supposed to be finding. Frequently, the cheapest option, I think, is the one that is going to have to be maintained by somebody for a very long period of time. And that somebody happens to be the states, at which level of government there is no provision for long-range maintenance. So you end up having the states not wanting to implement the solution that EPA studies would suggest ought to be implemented, because it shifts the financial burden from the Superfund to the states without a Superfund. And we don't happen to have one. So again, I think those two problems, which delay and make more difficult the development of a solution, are being driven by this liability problem.

Rogers: Can I return to what I see as the emerging big issue here?

Kirk Sniff of EPA

And that is: is EPA going to stick by its announced policy of, as you put it, Kirk, looking at a site as an organic whole, and trying to get all the costs of the cleanup back from the responsible parties? If so, I think that this program, if its not doomed, it means that you better get a lot more lawyers. From my experience, most of the sites in the country are sites in which you have a percentage of the generators known, and that percentage can range from 90 down to 10 percent. I'm in a case right now where there are 14,000 drums; we've contributed 28 drums, and the government alleges it knows of maybe 100 more drums. And they're saying "joint and several liability."

But I think the garden-variety case is where you have 10 or 12 companies that contributed 30 percent of the volume. It's purely fortuitous who your company is, who your companion generators are, in these cases. If the government really intends to go for 100 percent from those groups, that is going to be perceived forever—and I don't think there's anything that the government can do to change this perception—as being unfair.

Most corporate environmental managers in this country say to themselves, "I don't understand Superfund. I think it's illegally retroactive. But like a lot of unpleasant things in life, I'll live with it." This official then asks, pragmatically, "How many of my drums are there? What's the total tab?" And after they get over the shock of hearing that, they often say, "Okay, I'll give them my *share* and get out of this thing." And you're saying that isn't going to happen. You will not accept their share. I think those two policies are going to butt heads for the next few years, and I think it's going to result in enormous lawsuits, wasteful lawsuits.

If there's one thing that I hear from EPA these days that is standing in the way of really getting on with the program, it's the policy that eventually there's going to be 100 percent payment from the private sector, no matter how many generators are involved and no matter what percentage of the waste at a site you can identify with those generators. I just think it's totally unrealistic, and I think it's counterproductive.

Weinberg: Certainly if you view the statute as a complex, unprecedented, and arbitrary insurance scheme that seeks to shift the responsibility for payment of certain clean-up costs onto one class of people, who at the time they were undertaking certain actions did not expect to pay those costs, there's no inherent reason why one group of people—whether it's the states or generators or federal government—should pay rather than some other group.

I tend to agree with Jim, that in most experience that I've had, companies will make decisions based on their good-faith judgment as to what their relationship is to a site. Despite all the doubts as to the legality and appropriateness of the program, it will be possible to get people to contribute a fair share of the cleanup. But ultimately in many, many of these cases, there's going to be a large portion of the expenditure which can't be fairly allocated. There's simply no way to tell where material came from.

The government's position to-date has been, "We have records that we think account for 50 percent of the material that went to the site. We will then look at the other 50 percent and apply the same proportion." I think that is poor public policy, since it has penalized companies that historically have had good records and an environmentally responsible program that kept track of where their material was going.

Hall: I'm a little puzzled by all this. In 1980, chemical people had the chance to accept an apportionment scheme under Superfund of the kind that you are talking about now. And they rejected it. The sorts of things you're talking about do go, or can go, to "joint and several." Or you can consider them separately from joint and several, if you accept the fact that joint and several is going to be a basis of liability under the statute.

But the versions of Superfund that were being discussed in 1980 had joint and several coupled with an apportionment scheme, the type of thing you're talking about now and that was rejected by the chemical companies. Joint and several is something that's just *got* to stay in the statute. It's something that the courts will ultimately recognize, I'm convinced, because it makes sense and its the only way the statute in the liability provisions are going to . . .

Weinberg: Khris, why does joint and several have to stay in the statute, positing that it's there already?

Hall: If joint and several isn't in there, the burden of proving liability for any individual chemical company falls upon EPA to say "Dow contributed 10 percent, Union Carbide contributed 20 percent." And that's a burden that EPA cannot meet.

Eichbaum: But if you substituted for it and agreed upon an apportionment scheme, and recognize that the question of historical liability is secondary to clean-up, why does that matter?

Hall: It matters because there should be some cost recovery, as much cost recovery as possible. It should be a secondary interest, but it is needed to make sure that the fund continues operating and to make sure that people who are fundamentally responsible for the site pay for it. The burden should not be on EPA to prove to a degree of certainty what the individual's contributions were. EPA's not in the best position to know that. The individual companies are in the best position to know that.

If you want to go back to Congress in 1985 and say, "Fine let's agree on joint and several, but let's have an apportionment scheme," where Dow can come back and show they're responsible for 20 percent, that's something that I think is reasonable.

Weinberg: You see Khris, the inconsistency with your position, as I see it, is that if one presumes that the people who are ultimately responsible for the site are solely the generators; and that the government won't be able to prove what generators sent to a site, you are inherently increasing the litigation in this program. But that is inconsistent with your desire to see the sites quickly cleaned up.

Hall: No, it's a secondary issue. You clean up the site, then you fight out that issue.

Weinberg: But there's no factual basis on which to fight out the liability issue if you move as quickly as you would like.

Eichbaum: The problem—and this is the one that I tried to identify—is that the clean-up cost defines the level of maximum liability of the private sector. They are going to want to argue about keeping that dollar down. And that's why we aren't getting anywhere.

I guess that their desire to make that argument is increased the more they are exposed to liability. Now I don't know whether the theoretical apportionment scheme, in retrospect, appears to them to have less exposure rather than more. Maybe that's what you're really re-thinking.

Rogers: I want to take you on, Khris, on your joint and several holy war.

Hall: I'm not sure why you characterize it that way. I've got Anne Burford agreeing with me on joint and several after all.

Rogers: I think some benighted judge somewhere is going to say that there's a rule of reason in the joint and several world. You can't seriously suggest that someone who unknowingly shipped one percent of the wastes to a site—should pay for the entire cleanup.

Hall: I'm not going to deal with the question of knowing versus unknowing. One percent I will deal with. It sounds an awful lot like the one-barrel hypothetical that we had to deal with, and I think very unreasonably, throughout the whole liability debate. There *is* a rule of reason. There always has been a rule of reason with joint and several, and that is, if you're not a significant contributor, you're not liable. And that rule of reason will be exercised. And it could be written into a statute. It *was* written into some earlier versions of joint and several that got nixed.

Rogers: I have never heard anyone in the federal government state that there is a rule of reason or a de minimis cutoff. The position I am putting forth is that there are going to be situations where EPA is not going to be able to get 100 percent reimbursement from generators, because they have contributed, in the aggregate, too small a percentage of waste to a site. Do you accept this?

Hall: I think a court could very reasonably find that if you got 140 contributors—all of whom contributed one-half of a percent or 1 or 2 percent—that each one of them incrementally may be a significant contributor. On the other hand, if you've got a situation where you've got contributors of 30 and 40 percent, and one guy who had one barrel in there, that one-barreller is *not* going to be liable.

Rogers: I'm not talking about one barrel. I'm talking about people who have contributed less than 1 percent—and I exaggerate not one witt here—people who have contributed less than 1 percent who have been told they would have to pay for the entire cleanup. And they've been told by EPA regional attorneys that unless they write a check for the entire cleanup, don't bother to come to the regional office.

I can give you several examples of that. I think it is outrageous. I think it's embarrassing. I think as long as we talk in abstractions about joint and several and don't start talking about some common sense in these things, this program isn't going to get anywhere.

Weinberg: I don't think you can talk about joint and several with 25 percent.

Hall: Well, 25 percent I think is very significant.

Weinberg: If in fact the proofs are that a company was the source of 25 percent of the material that went to a site—let's assume that it is a simple site, so there's no question about degree of hazard—I'm still unpersuaded that joint and several is required. The facts are 25 percent. Now if we have made a policy decision that a generator should—despite the state of the law at the time he dealt with the site, despite his best management practices, perhaps despite the fact that he was directed to the site by state regulators—now be required to pay a share of the clean-up cost based on what he sent to the site, I consider that going quite far down the road in terms of public policy. It is not inherently evident to me why that company should also pay some share of an unallocated expense.

Eichbaum: I have to represent the people in Maryland who are concerned about this problem. And if one of them were sitting at the other end of this table, who has a site that she very much believes ought to be cleaned up, and then listened to the last hour of this conversation, she would be prepared to throw *all* of us into the deepest part of the Potomac River—if not out the 7th floor window of this building.

Because I think we are talking in rather arcane legalistic language and about issues which again are *not* resolving the fact that sites are not getting cleaned up. If we can't come up with some suggestions, what I hear is that the result is inevitable: Unless some dramatic changes are made, it is going to be worse, just based on the last hour of this discussion. Because there are such difficult legal problems that are of such moment to the private sector, that they will not allow this program to go quickly.

That's what I hear as the net result. Unless that's addressed, we are in very bad shape. I suspect that we ought to try and think about some of the mechanisms—and I guess I'll use my word—of "decoupling" action from liability or we aren't going to clean up sites and we ought to just recognize that. That this is a program that's going to take 20 years, that's going to involve a level of litigation of the type that existed around the independent regulatory agencies during the 30s or the 40s before we even know what can be done.

Rogers: Can I try to summarize your statement and put it to the EPA people?

Eichbaum: I'm not sure they're the only ones you

Former EPAer Jim Rogers, now representing industry generators, listens as Bill Eichbaum of Maryland makes a point.

put it to. I think perhaps that we all need to have it put to us. But go ahead.

Rogers: Are the EPA representatives here willing to go in and clean up a site quickly, efficiently? At the risk of destroying evidence, hurting a case, perhaps not even bringing later enforcement action for recovery of those funds? And I want to ask Khris Hall, would she let them do that?

Sniff: I don't think there's any disagreement within EPA at all that the most important thing in moving on a site is to resolve the danger to public health or welfare. That comes above anything else.

If that means that chain of custody procedures are violated, that's a cost we're willing to bear in order to protect public health. That's obviously the most important thing. Hopefully, we can develop procedures that will ensure that evidence is preserved. We're new in this business. In fact, the government has never gone into cost recovery in this magnitude. And I would wager that we'll have problems, and we'll have to deal with them as the situations arise, but under any condition our first priority will be to resolve an immediate hazard to public health.

Khris Hall of EDF and Kirk Sniff, EPA Associate Enforcement Counsel for Waste Enforcement

Cherney: I would like to comment on that. You asked a question in somewhat of a black-and-white form. Actually, of course, it will be a balancing question in all of these instances—and that is the key to resolving the conflicts that we're all raising.

The same question needs to be asked of *your* clients, Jim. Is the industrial community willing to—if it believes that its "fare share" is 30 percent, for example, put forth 35 or 40 percent to get the sites cleaned up? Is that company willing to go a little extra? I think there will have to be a little give on each side in order to clean sites up through settlements.

Rogers: My sense is that if the government has an apparently legitimate case that "X" percent of a company's wastes ended up at a site, that company more often than not will swallow hard, forego legal analysis, forego the other type of adversarial opportunities, and say, "All right—let's get rid of this case. I'll write a check for that amount."

But what I'm saying—and I want to emphasize it—is that that does not occur in this country right now, because EPA doesn't allow it to occur. I am talking about going into EPA regional offices and saying to the EPA regional attorney, "What percent do you think we contributed? What do you think it's going to take to clean up this site?" And right then and there offering to write a check for that share. Then one is told that it may be a year, it may be two years, before they determine exactly what the total clean-up costs are, and, moreover, it is the government's policy *not* to have partial settlements such as that.

Weinberg: And, furthermore, you may ultimately be held jointly and severally responsible for far more than whatever that number is.

Rogers: And let me try to add one more element to this, because I do think its important. That is, we're not talking about small differentials in costs of clean-up when we talk about shifting from a program designed to quickly and efficiently clean up a site to a program designed to clean up the site and preserve the evidence such that you can go into a federal court room later on.

The primary distinction is that in the latter situation you have to go in and do a gas chromatograph analysis on every drum in the site to prove whose wastes are in it. You don't need to do that if you're just trying to protect your contractor's employees who are cleaning up the site. You can use intelligent choices of what drums to look for to protect the people and to dispose of the liquids properly. We're talking about orders-of-magnitude difference in costs. Here is an opportunity, you see, for the private sector to come in and say, "You don't need to spend $5 million analyzing every drum. You can spend $50,000 because you don't need to think about a later lawsuit. You say there are 30 generators who contributed 20 percent. We 30 generators will give you that share of the money if you release us from liability."

And there is a site, if the government can't find evidence to demonstrate the identity of the generators of the other 80 percent, where the Super Fund—with a capital "F"—should go in and finish the job. And all of us taxpayers should not pay the extra amounts for trying to create a joint and several case against the 20 percent.

Sniff: That's not the typical case. In a typical case,

EPA Superfund Attorneys Kirk Sniff (left) and Coke Cherney (right).

we can account for generally something around 70–75 percent of the volume at a site. In those cases, the agency should not be burdened with the responsibility of apportioning relative liability among potentially responsible parties. That allocation is the responsibility of the potentially responsible parties. In some cases we've seen generators who have aggressively taken the lead in organizing and doing that.

Hall: I'm not going to sit here and listen to joint and several being attacked without responding. But I thought we were making an effort to get away from joint and several liability and I'd like to do that. I mean we could spend the next two hours on joint and several if we wanted to but that's not really why we came here today.

Rogers: Well, wait a minute now. I think it is tied in with everything that goes on in the Superfund program—inextricably linked with the public policy issue that Bill has put on the table—going in and cleaning up. I don't think you can think through this program without getting into some of these very difficult issues. So I defend the continuance of joint and several on the table as a topic.

Weinberg: We have now proved that there are lawyers in the room by shifting from the merits to procedure. [laughter]

Eichbaum: And that is why [Jane Smith] threw us out of the window! [laughter]

Hall: At any rate, Bill asked me a question that I would like to respond to. And I'm trying very hard to stay away from joint and several. The first responsibility, the first priority, *is* cleanup. What's done should be taken with an eye towards that. Now I don't think in many instances cleanup is inconsistent with getting evidence in a case. I agree with Jim that you don't have to go in and shouldn't go in and analyze every last barrel. However, you can't go in and clean up without knowing what you're cleaning up and without having taken some samples, and without having analyzed some of what has happened. The in-depth studies that should be done before every clean-up can also be used for evidentiary purposes. It doesn't take that much time and effort to observe chain of custody procedures.

Weinberg: Khris, as a practical matter in some cases, you may be right. But I can point to specific examples where a simple compatibility test in a bulking of materials, and an analysis of those bulked materials, would allow you to quickly move drums from a site. But if you are worried about showing where each of those drums came from, the agency has insisted on an analysis of every single drum's contents. If you start playing that game, you're going to use up a lot of money very fast for no environmental benefit—that's a purely legal benefit.

Hall: I'm agreeing with you that we shouldn't have to analyze every time. But I don't think even if EPA were planning an enforcement case they would have to analyze every last single problem. As I said, the first priority should be cleanup. But EPA, in planning the cleanups, in doing the studies, should be mindful of observing proper procedures that might be useful in a court.

Cherney: I also agree with that. However, I think it's interesting that attorneys representing chemical companies would advise the agency not to waste its money doing this type of analysis. In a cost-recovery action, they probably would say, "My gosh, they didn't do any analysis. We can't tell if this is our chemical."

Weinberg: It's not an issue of wasting the money, because I think the position that Jim and I are suggesting is this: If you are going to plan to litigate that case later on, and look to extend whatever records you have on paper, you in fact do have to undertake that analysis. You are in fact going to have to have that evidence put before the forum.

Hall: Who's going to have to have that evidence?

Weinberg: EPA.

Hall: Not if there's joint and several, which is why joint and several is important.

Ward: I'm going to ask each of you, if in the next month or two months you have 15 minutes in with Bill Ruckelshaus, what do you advise him on this program?

Rogers: I would recommend that he get people who are experienced, intelligent, that they be well-known for their proficiency in their disciplines, and that be *used* in their disciplines. You need the appointed officials to listen to these people and to trust these people. You need to allow the agents of the agency, whether they be regional attorneys or some other official, to make sensible decisions in the regional office and to back them up. But there has to be a restoration of the trust in the bureaucracy, and there has to be a restoration of the reliance by the top people in EPA on the career and other valuable civil servants. Because, as is clear from this discussion, we're dealing with topics that have enormous complexity from a legal and a technical point of view. They're not suited to political decisions. They're suited to decisions by people who have been in these fields and who have thought about these issues for a long time, and those are the career people at EPA and Justice.

Weinberg: I agree with Jim, but I would add one other thought. Mr. Ruckelshaus is going to have some period of time at the agency in which he has broad-based support. I would hope that during that period, which inevitably will be truncated by some event down the road, he comes to grips with some of the questions that we're talking about that have policy implications. I do think there are two inconsistent principles at work in this program. If one is to move quickly with clean-up, one is going to have to sacrifice some of the extended liability that Khris would like to see. I believe that those decisions could be made over the next few months by Mr. Ruckelshaus given the respect that he's going to have as he begins that job. Over time it's going to become more and more difficult to reach those kinds of decisions, for political reasons—I say small-*p* political reasons, not partisan political reasons.

Eichbaum: Well, I agree with what Jim said in terms of the proper use of the personnel at the agency, and that is critically important not only in Superfund but throughout the agency. I think I've learned perhaps more than I've contributed, but it is clear to me that the liability issue, unless resolved differently than it is now being resolved, is going to preclude rapid clean-up of the sites. And therefore I think that has to be dealt with. I would think that it is possible, within the framework of the existing statute through a rulemaking process, just as EPA uses a theoretical Mitre model for determining what is wrong at a site and where it ranks, that EPA ought to be able to come up with a model for liability which the various interests could agree on for a *class* of sites. What that would be, I don't know—but the model would be applicable and therefore would cut through all of the legalistic argument, allow cleanup to move forward rather quickly and rather inexpensively. In that class of case where that model was applied, you in fact could allow some reasonable form of recovery to take place against the private sector. I guess, based on what I've heard, that that is pretty much of a priority or it's going to be difficult to move forward.

Hall: My advice would be to continue what I'm hearing now as a shift in policy by EPA to put more resources into cleanups faster. My advice on the liability issue is to keep it as it is. I do not see it as an impediment to quick cleanups at all. I would also like EPA to take another look at the National Contingency Plan. I think some of the problems with the way cleanups are *not* proceeding lies in the vagueness of the National Contingency Plan. I think it's critical that there be firmer standards for cleanups of these sites. In addition, I would urge Mr. Ruckelshaus to make sure that the public is more incorporated in this program, both for whatever private settlements *do* come along down the road and in terms of whatever fund-financed cleanups take place.

Rogers: How do you do that?

Hall: You keep the public informed. You specifically make material available for them. You provide them with a way of influencing what's going on whether it be public hearings or informal meetings in the enforcement setting. You would allow them the right of intervention where that's appropriate. Keeping them informed of what's going on, giving them access to materials, and giving them—at discrete appropriate points—a say-so in the process.

Weinberg: You're very careful, Khris, in saying public participation at "appropriate levels," and as long as the statement is made that way I suspect nobody has any difficulty with it. But what is "appropriate?" What, for example, are shortcomings of a situation like the Seymour settlement, which after having been negotiated was filed, subject to vociferous public comment, and then approved by a federal judge?

Hall: Well, I think that's one important step. However, not all citizens can afford to hire a lawyer to go into court for them. I think that before something is submitted to the court, there ought to be a method of public input so that a citizen's group does not have to go through the costs.

Weinberg: That was published in the *Federal Register* and made available for public comment that way as well.

Hall: It was published in the *Federal Register*—how many people in Seymour, Indiana, read the *Federal Register*? In addition, as it was published in the *Federal Register*, 10 days notice were given. Well it turned out to be more, but if you just read the *Federal Register* notice, you thought you only had 10 days. People in Seymour, Indiana, don't even get their *Federal Register* in 10 days.

Weinberg: So what is the "appropriate" level that you're talking about?

Hall: Well I don't think I've got a firm plan, and we're willing to listen to a lot of discussion on this. This is one issue that we have raised in litigation with EPA, and I well recognize that you cannot and should not litigate in a football stadium—although that's exactly what some of these negotiations sound like to me, with all the industries present. But there are key points where communities can be informed of what's going on, and their views can be taken and taken into account. I think that's something that deserves further discussion.

Rogers: Are you saying that the attorneys general of the various states and the representatives of EPA are basically inadequate to carry out the day-to-day intense—and I mean intense—negotiations that have to take place on these sites? Are you suggesting there has to be another group at that table?

Hall: If you're talking about a public credibility problem, if you listen to people who have been talking about hazardous wastes and Superfund problems, the one thing they will tell you is that you can't trust your officials. Now I don't make that statement myself, I have been a Justice Department official at one time. But that is the perception of the public.

Now the day-to-day negotiations, it is true, can and should be carried out by government officials. But there have to be decision points. There have to be points at which the public is allowed to enter the scene, to be informed to whatever depth they want to know what's going on, to be given all raw material and data, and to make some decisions on their own about what's appropriate for their future, and that has to be taken into account.

Eichbaum: I want to agree with Khris. It is clear to me, in the two Superfund sites that we've dealt with, that public acceptance of what we did at those two sites was not predicated on the fact that *we* cleaned them up, but was predicated on the fact that the public was very closely involved with the process and that *they* believed that the sites had been cleaned up. *They* believed that because of the information they got, the meetings we held with them, etc., etc. I certainly don't think it's necessary that the involvement of the public be of a *legal* nature. I mean, sure those rights have to be protected. But I think it's infinitely more important, for any Superfund site in which there is public interest, that as an integral part in the scheme of cleanup, there be a very carefully thought through and well implemented scheme of public information and participation. That's got to happen.

Weinberg: I think this discussion shows another area in which the clean-up needs, the litigation needs, and now the public participation needs Khris advocates don't seem to fit very well. The agency has asserted that a considerable amount of information dealing with the technical situation presented at a site is not available under the Freedom of Information Act, claiming the enforcement exemption. Now without arguing the appropriateness of asserting that claim, if the agency believes that it is necessary to withhold a set of information and is willing to litigate that issue, as it apparently is, we come face-to-face with the fact that the agency is saying that its enforcement needs are inconsistent with what you're saying are its public participation needs.

Eichbaum: I'll answer that by saying sometimes that's true. And I think that the public, if it believes that there really ought to be enforcement, will respect that limitation, in my experience. If they really think you've got to go get "X" company and they *know* that if we give them the evidence that blows the case, they say O.K.

Hall: It may be that the citizen's groups don't want every last FIT team analysis either. They usually don't have the resources to look at them. But they do want some technical material so that they can form their own judgment.

Ward: Can I just put the EPA people on the spot on what they would advise Ruckelshaus? And particularly I'd like to get Kirk's comments on resources, which Khris raised, relative to Ed Kurrent's memo. Does any of this matter if Ed Kurrent's memo is correct?

Sniff: Can I answer the first question first? One of the things that's really necessary to address quickly, I believe, is development of a policy *at all*. I believe that the new Administrator should develop an articulated policy which calls for decisionmaking at a fairly early stage, as soon as you have enough information to make an informed decision. And you either clean up or you enforce. And the enforcement approach would then hopefully be governed by some realistic time lines. And I also hope that such a policy would encourage the full use of all of the tools that are available, whether that's Section 104, letters, or Resource Conservation and Recovery Act 3013 orders—the full arsenal that we have available, once a decision is made that we should proceed along the enforcement track.

I hope that we will move away from some of the earlier attempts at a dual-track system and make a decision at an early stage and hopefully resolve a number of these apparent conflicts between immediate cleanup and enforcement by choosing one or the other quickly.

Cherney: Well, I said at the outset that I think that among other things the events of the past several months create an opportunity to re-examine what we've been doing and where we can improve. I would advise the Administrator to utilize both of the separate but related authorities under the Act, enforcement and clean-up. And even if they are, as David suggested, inconsistent, that's the reality of the statute at this point. Streamlining the decision process, as Kirk has emphasized, is probably the most important thing we can do, given the reality that these are the tools currently available. I would urge that we not go back and forth between enforcement and cleanup but rather that we make a decision, stick with it, and get the sites cleaned up as quickly as we can.

I would also counsel a reasonable and fair approach to the problem. In considering fairness, which both Jim and David raised, I think we have to think not only about fairness as it's viewed by executive officers of chemical companies, but also fairness as I believe it was established in the statute. There isn't enough money in the fund to clean up all these sites, and the additional money is going to come from someone. Whether it ought to come from the general taxpayer, the corporate taxpayer, or those companies who contributed waste to sites which require clean-up is a question that I think Congress answered in enacting Superfund. I think we have to look at all those things in developing further policy.

Rogers: What I think this discussion has shown is that the policies, after a few moments of discussion, hang on details. We're struggling for details, we're struggling for some idea of what the congressional leaders who passed this law intended. I think that perhaps one moral of this story is that it is time for Congress to stop having an oversight hearing every day, and to take up details such as "joint and several." When does joint and several apply? When is there strict liability?—These issues that are going to consume us all in very intense litigation over the next two years.

It's time for Congress to really focus on the nuts and bolts of Superfund, because that's where this program is going to be made or is going to be broken. And it really is unfair, I think, for the Congress to leave entirely to EPA the task of creating a sensible policy out of these conflicting themes in Superfund and out of very confused and skimpy legislative direction. I think that the one group in the last six months in this city that deserves the most criticism for this uproar at EPA, and for the general state of environmental protection, is the Congress of the United States and those committees with authority to deal with the substantive laws. I think, as everyone here recognizes, when you do try to get into the nitty-gritty it quickly loses its sex appeal. The members quickly leave the room. Most of the staff members want to go on to something else. And thus, the rest of us are left arguing for years over these things and forcing poor federal judges to try to make some sense out of national policy when the facts of a specific case may well not be appropriate for fashioning that policy.

Eichbaum: I might just change that a little bit.

I think EPA, at the policy leadership level, brought the congressional attention down on itself by having departed in many ways from what Congress thought it had told the agency to do.

But I do think you're right that now the risk—and this is what I said at the beginning—is that having dealt with that political leadership and perhaps having now created a new opportunity for EPA to move in a different direction, continued detailed attention to each of these statutes in a nonconstructive way may continue to make it impossible to move forth positively. I think perhaps one of the best things Congress could do is now step back a little bit—keep a wary eye, but give some breathing room. ☐

CHAPTER II

THE PROBLEM OF SCIENTIFIC AND MEDICAL UNCERTAINTY

An Excerpt from the National Science Foundation report:

COMPENSATION FOR VICTIMS OF TOXIC POLLUTION-
ASSESSING THE SCIENTIFIC KNOWLEDGE BASE (March 1983)

CHAPTER 5: UNCERTAINTIES ABOUT TOXICITY AND ENVIRONMENTAL EFFECTS

Philosophers have long recognized that law and the sciences understand causation in fundamentally different ways that are reflected in the differences between scientific and legal proofs and demonstrations. Law demands sharp distinctions, where science sees gradations. That legal proof demands stricter standards of what will count as cause and as effect than may be obtainable -- not only in the current state of knowledge of a given science, but even at an advanced state of knowledge -- must be borne in mind in this study of the adequacy of scientific and technological knowledge for implementing programs to compensate victims of toxic pollution. Like most scientific findings, data on environmental health remain incomplete and tentative. It is worth noting that ancient law presumed that such problems would be solved by jurists with sufficient and general scientific training. In Roman law, specialized fact-finders were sometimes employed for particularly esoteric matters, and in Jewish law the Judges of the Sanhedrin were themselves required to possess knowledge of the general sciences.[1]

Price[2] has distinguished between modern, "big" science and ancient "little" science. The degree of specialization and fragmentation in modern science effectively moots any effort to create a scientifically trained expert judiciary. Cohen ably reviewed the linkages between science and the law spawned by this specialization.[3] The movement of science into new domains of research, experimentation, measurement, and technical achievement expands legal issues. As Judge Bazelon observed:

> . . . the judiciary is increasingly being asked to grapple with scientific and technological issues of great complexity. Some two-thirds of the D.C. Circuit's caseload now involves review of action by federal administrative agencies; and more and more of such cases relate to matters on the frontiers of technology.[4]

We stand on the "threshold of a new era," according to Bazelon, for two reasons relating to matters of health and safety. First, unlike more traditional administrative matters such as rate-setting, the issues of environment, health, and safety touch on personal interests, thus reflecting higher stakes and stronger emotions. Second, the new health and safety regulatory issues deal with uncertainties and imponderables, readily acknowledged by experts in the fields involved.[5]

The willingness of experts to acknowledge these uncertainties presents the law with a host of difficulties. Law rests on the presumption that there is a knowable "truth" and that it ranges along a continuum: at one end is the administrative presumption that a finding is more likely than not to be correct, and at the other is the notion that a finding is true beyond a reasonable doubt.[6] Science, however generates hypotheses or theories that, even when confirmed, exhibit varying degrees of probability.[7] Studies of science itself, the sociology and history of science, document the extent to which extra-scientific factors, ranging from the personalities and cognitive interests of the scientists, to wars, whims, and even the kind of data adduced, all affect scientific process and progress.[8] Some persuasively suggest that science differs from politics chiefly in its subject matter, and that the very decision to study a particular problem is itself a political and subjective issue.[9]

For these reasons, some courts have expressed exasperation with experts. Judge Jerome Frank commented on the undemocratic impulse behind scientific guilds that may repress dissent:

> Generally they create closed guilds which, resenting what they consider uninformed criticism from without, often also develop something like tyranny within. The very respect which their skills win for them from the public tends to make them smugly authoritarian toward the public. The specialist group evolves its own routines which, grown semisacred, are guarded by its leaders against significant change. One who, within the guild, seeks to break up any of those routines, is likely to be regarded as a silly ass or a dangerous disturber of the intellectual peace. Unless and until he receives the blessing of the guild's leaders, he will not be accorded a fair hearing. And if he does receive the blessing, in all probability he, in turn, will come to insist that his new truths are beyond question. His new ideas, supplanting the dogmas he attacked, become themselves dogmas. He now has a prestige-monopoly, a vested interest, which he will fiercely defend against other innovators.[10]

Divergence of scientific opinions poses special problems for those attempting to assess appropriate compensation for pollution-related disease. While differing opinions may spur science to generate better hypotheses, they force courts and administrators to make judgments on the basis of incomplete and tentative findings. Some may argue that this is what the law has faced all along, but such acknowledged uncertainties make the role of the evaluator and decision-maker all the more demanding.

Scientific Causation

Since the issue of causation is central in all the compensation mechanisms we examined in Chapter 1, it is important to understand how scientists establish cause-and-effect relations between exposure to a substance and the subsequent production of disease. The two principal methods are animal experimentation and epidemiological evaluation.

1. Animal Studies. The causal link between chemical exposure and cancer in human beings has been based on animal studies. Although mice, rats, dogs, guinea pigs, and monkeys respond differently in degree than do human beings to any potential carcinogen, most scientists agree that there is an excellent correlation between the qualitative fact of carcinogenicity of chemicals in these generally used test species and in human beings.

Principles and technical considerations underlying the identification of potential human carcinogens have been discussed widely. Rules for weighing the evidence for human carcinogenicity on the basis of animal bioassays have not been formulated. It is difficult to decide when the data are sufficient to establish human carcinogenicity. It is especially difficult to know when sufficient negative evidence has been obtained (tending to support a conclusion of noncarcinogenicity).

The use of animal data to describe the shape of the dose-response curve is an integral part of most schemes to estimate risk to humans, but such use involves two fundamental problems. The first is primarily statistical: whether data from the relatively high-dose levels of exposure in animals can be extrapolated to the lower levels corresponding to a small prescribed risk level. The scale of reduction is very great: a factor of 10^{-5} or 10^{-6}. The second problem is physiological: the dose level for the test species must be converted to its counterpart, in terms of effect, in human beings.

Although several mathematical models can be applied to the estimation of carcinogenic risk at exposure levels comparable to those of normal exposure, attempts to relate the calculated level of risk in an animal to actual human risk are greatly limited. Specific limitations arise as a result of factors involving major gaps in scientific knowledge, such as the following:

- Laboratory animals and human beings exhibit variations in sensitivity to specific chemicals.

- Test animals are genetically homogeneous; human beings are not.

- Exposure of test animals starts after weaning; human beings may be exposed either in utero or during later life, or both.
- Laboratory animals are uniformly healthy and well-fed; many human beings are poorly nourished and sick.
- There is no way to assess the quantitative effects of random complicating events potentially affecting human beings, such as exposure to promoting agents, synergistic species, and other carcinogens.

2. Epidemiological Studies. An epidemiological study focuses on the demographic distribution and diagnostic determination of disease and injury in human beings. It assesses risks of disease in groups of individuals rather than determining the presence or absence of disease in any single individual. Well-conducted and adequately documented studies can provide a scientific basis for public health decisions, since epidemiology relates to causal relationships between specific environmental exposures and subsequent manifestations of disease or injury in a population. Historically, most known environmental hazards have been identified through the unusual occurrence of disease or injury in human populations and have subsequently been documented by controlled studies of human beings and especially animals. This is true specifically of cancer.

Several agents for which the animal model has proved insensitive are known to cause disease in human beings. A major strength of epidemiology is its species-specificity, which can provide a direct measure of risk to human populations. However, epidemiological methods are also subject to several limitations. They tend to be insensitive for detecting relatively low-level risks, because of their inability to identify or control possible confounding differences between exposed or unexposed groups, the inadequacy of sample size, and the difficulty of discriminating between elevated relatively small additional risks and large pre-existing background risks. Epidemiological studies are also very costly and often difficult to conduct because of the long lag period between exposure to a substance and appearance of a cancer. Epidemiological methods are thus inappropriate for assessing associations between newly introduced environmental agents and diseases characterized by long latency periods.

Love Canal Residents Under Stress

Psychological effects may be greater than physical harm

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The government's decision to help relocate 710 families living near Love Canal has done little to dissipate the miasma of fear and anger that envelopes the area. "People are very, very frightened, almost panicked," said Lois Gibbs, president of the Love Canal Homeowners Association, 3 days after the decision, which followed on the heels of an Environmental Protection Agency study that showed chromosome damage in 11 of 36 persons tested.

Panic, said Gibbs, was why the homeowners association kept two EPA officials hostage for several hours. The action, she says, was a "direct result" of the study being released "with nobody to tell us what it meant or what they were going to do about it." If the EPA officials had been let out the front door, "they would have been torn apart."

In the almost 2 years since the families living nearest the old chemical dump site were evacuated, residents of the surrounding area have been living under tremendous stress. So rancorous had the atmosphere become that a couple of weeks before the latest relocation decision, one mental health worker says, "we thought they [the residents] were going to torch the neighborhood." Although no one has yet come up with the unassailable evidence that chemicals from the dump site have been making people sick, there is enough to convince people that they are being poisoned and that the authorities are more interested in soft-pedaling the problem than in protecting the public's health.

The psychological damage from this long-running disaster may ultimately turn out to rival and perhaps exceed the physical damage. Love Canal has elements in common with two other recent situations. One is the accident at the Three Mile Island nuclear facility. Despite the fact that there were no adverse physical consequences of the release of radioactivity into the environment, a large portion of the population was profoundly alarmed, and ignorance and misinformation from those in charge created a deep and abiding mistrust.

The residents of the canal area may have even more in common with Vietnam veterans who believe their exposure to the dioxin-containing herbicide Agent Orange has led to cancer, birth defects, and a variety of other disorders. In both these instances there are real sicknesses to contend with, and the sufferers feel helpless and betrayed by the government's apparent unwillingness to move swiftly to set things right.

The kind of stress residents of Love Canal have been under is similar in many ways to what happens in the wake of a natural disaster. But there are significant differences. A Red Cross worker says "give us a fire or a tornado or a flood any day:" A natural catastrophe is time-limited, and governments generally have well-oiled apparatuses ready to roll in the event of one—witness the generally efficient management of the effects of the Mount St. Helens blowup. But at Love Canal, the nightmare goes on and on. And once the dust finally settles, the residents may spend the rest of their lives wondering when poisons in their systems will erupt and worrying about the effects of exposure on their children and grandchildren. Authorities have been at a loss about how to handle the immediate situation, not to mention the long-term one. As the Love Canal Homeowners Association has observed, "there is no policy which the Love Canal situation fits."

The Niagara Falls Community Mental Health Center has tried valiantly to relieve distress, deploying three outreach workers full-time in the Love Canal neighborhood. They put together a special pamphlet for Love Canal residents on "coping with stress" and publicized various counseling programs. But people who have chosen to avail themselves of these services probably number no more than 100. The residents are mostly blue-collar workers, the men employed in chemical plants or auto parts manufacturing, who attach stigma to mental disorders and who in any case would tend to ascribe their problems to the obvious causes of health and financial difficulties.

Thus, it appears that the Love Canal Homeowners Association, formed in

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August 1978, has emerged as the primary cohesive force and source of help and information to the community. Lately the office has been in a state of chaotic activity, acting as the central source of information for people affected by the recent relocation decision. The Love Canal people feel betrayed by all levels of government, says association president Gibbs. They are furious at the state government for telling them things were all right when they were not and for withholding the results of several health studies. Lately they have been comparing themselves to Cuban refugees for whom the government has opened an Air Force base. They have been trying for 2 years to get access to a local Air Force base, which has finally made 90 units available to them.

It is the uncertainty that is grinding everyone down the most. It will be 4 to 6 months before EPA's newest health study will be complete, and during that time everyone will be perched in hotels and apartments, living in limbo until they find out whether they will be allowed to return to their homes. Meanwhile, they fear for belongings that have been left behind, their homeowner's insurance is running out, and (unlike the 237 families in the first evacuation) they have no guarantee that the state will step in and buy their houses.

Events have taken their toll in both physical and mental health. Informal surveys conducted with the aid of Beverly Paigen of Roswell Park Memorial Institute have convinced residents that what they see as a high rate of miscarriages, stillbirths, and birth defects is a direct result of exposure to poisons. The surveys also seem to indicate high rates of cancer, respiratory problems such as asthma and emphysema, urinary system problems, and liver and kidney disorders. But the survey evidence is disputed by the scientific community and serious questions have been raised about what, if anything, the surveys show. Nonetheless, the residents believe this evidence and suspect that poisons affecting the central nervous system may be implicated in nervous breakdowns and suicides. There were 17 breakdowns and 7 suicides among 550 families in the decade before the Love Canal problem was exposed.

Many people are purportedly suffering—very much like the alleged victims of Agent Orange—from a vague assortment of psychophysiological problems such as depression, irritability, dizziness, nausea, weakness, fatigue, insomnia, and numbness in extremities.

Even if the health damage from the chemicals could be definitely ascertained, it would be extremely difficult to sort out which health problems result from poisoning and which can be ascribed to emotional stress. The epidemiologic picture is further muddied because of pending damage litigation against Hooker Chemical Co. It is well known, particularly in the field of industrial medicine, that people are much more likely involuntarily to continue suffering the effects of a disease or injury when they stand to gain money from such suffering.

One thing is certain: the Love Canal situation has not been a promoter of family unity. Gibbs says the homeowners association has found that among the 237 families involved in the 1978 evacuation, 40 percent of the couples have separated or divorced. She thinks the tally from the 710 families involved in the latest relocation will be even worse, as the families are worn down from 2 years of stress and uncertainty.

The typical family situation, she says, is that the wife wants to leave and the husband says they cannot because he has invested his life in the home and his work. The wife insists they must move for the sake of the children, the husband says they can't afford it. So the wife leaves with the children.

Gibb says the crisis has generally had a more debilitating effect on the men than the women. "They feel they've lost all control over their lives. They have no choices. They can't protect their home or their children. I have never in my life seen so many grown men cry," she says. The men in the neighborhood are "macho" types who feel they should be able to protect their families whatever happens. But they are also law-abiding citizens who refuse to picket or engage in protest demonstrations or marches "because it's against the grain." Thus it appears that it has been the women of the neighborhood who have taken the initiative in trying to pull things together and press demands on the authorities.

A hand-made sign on the porch of a home at Love Canal.

FOR
SALE
8'2
CHEMICALS

EVACUATE
US NOW!
EDERAL
AID...

Love Canal family evacuates its home after the chromosome damage report.

Ironically, while families are disintegrating, the community as a whole has become more cohesive. Love Canal was not a close-knit neighborhood, but now people who never socialized with each other are sharing their problems and neighborhood quarrels have dissolved. "We could have some wonderful street parties now," says Gibbs.

Robin Bannerman, geneticist at the State University of New York (SUNY) in Buffalo, which has been supplying genetic counseling services to Love Canal residents, believes that "when the smoke has cleared, it may turn out that the greatest damage to health will be psychological and social." But so far, there has been virtually no social research done on the situation except by Adeline Levine, a sociologist at SUNY in Buffalo. Levine, who used graduate students to interview residents in August 1978 and again 6 months later, observes that tremendous additional stress to the residents has been caused by indecision on the part of government agencies and their failure to keep people informed. Levine also confirms that, like the alleged victims of Agent Orange, the people have been getting psychological help mostly in the form of self-help. They consider it stigmatizing to deal with mental health agencies, and in any case they do not believe any outsider can understand what they have been going through.

The federal government has no plans to conduct research other than toxicity studies. Calvin Frederick, head of disaster assistance and emergency programs at the National Institute of Mental Health, said that he would indeed like to be able to conduct research on Love Canal, but there is no way to get money for it unless the area is declared a disaster area by the President.

Love Canal may be the first of its particular type of disaster, but it is very likely not the last, as there are many hundreds of other sites around the country, mute witness to the old days of free and easy dumping. Now that the Love Canal situation has erupted, Gibbs says people are calling from all over the country for information on how to get organized, how to get appropriate health tests done, and so forth. In New York State and elsewhere, officials are undoubtedly wondering how many other communities—people who have been living for years with what appear to be unusually high rates of cancer and other problems—are going to get it into their heads that they, because of government negligence, are being slowly poisoned.

—Constance Holden

Just How Hazardous Are Dumps?

Everyone knows toxic wastes are hazardous, but there is little agreement about how to assess the potential risks to health

In October, the United States Environmental Protection Agency (EPA) finally issued a list of 115 hazardous waste storage sites that represent the most serious potential danger to human health. These sites were among the first candidates to be cleaned up with support from Superfund, a $1.6-billion kitty accumulated primarily from taxes on industrial chemicals. In November, however, the Congressional Office of Technology Assessment (OTA) sharply criticized that list, arguing that EPA had used inappropriate criteria in preparing the rankings. States and environmental groups have had their own thoughts about which dump and storage sites deserve first call on the funds.

These conflicting opinions symbolize the most crucial problem confronting individuals and agencies that must deal with the hazardous waste problem: There is no firm consensus about how to determine the potential hazard of chemicals at a dump site, the risk of exposure, and the potential health effects from such an exposure. The problems are not simply academic. A 1979 survey by EPA of 100 waste disposal sites produced an average estimated cost for cleanup of more than $8 million, with the cost at some sites running as high as $25 million. There are hundreds of such sites—perhaps thousands—and even $1.6 billion will not go very far. Hard choices are going to have to be made—and soon.

Part one of two parts

A good example of the problems involved is the highly publicized Love Canal area in Niagara Falls, New York, where homes were built immediately adjacent to a waste disposal site that was disturbed. Despite the great amount of time and effort that has been devoted to this volatile problem, it has been extremely difficult to document the extent of exposure of area families to the chemicals. There has been no conclusive evidence linking any such exposure to health effects in humans—particularly since some potential effects may not become apparent for at least another 15 years.

Investigators have even had problems defining precisely which questions should be asked about hazardous waste sites. There is consensus about only a few of the most general:

- ▶ What do we know about how chemical waste disposed onto and into the land contributes to pollution of air and ground water?
- ▶ In sampling and analyzing air, water, and other media, what strategies are most promising?
- ▶ How can human exposure best be estimated?
- ▶ What is the extent of normal human exposure to the chemicals in dumps?
- ▶ How can exposure to chemicals be related to human health problems?
- ▶ What are the health effects of mixtures of chemicals? Are they additive or synergistic?
- ▶ Are there existing technologies that have not been applied to the problem? What new technologies need to be developed?

These questions and others have been addressed at three major meetings during the past year. Proceedings of two of the meetings are now available in book form

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from Science, v. 215, January 29, 1982: 490-493.

and those of the third should be available sometime this spring.* Unfortunately, none of the meetings appears to have produced conclusive answers to any of the questions.

One of the biggest problems in approaching this task is the fact that, in the words of Clark Heath of the Centers for Disease Control (CDC), "Every dump is different. There are the classic dumps, with piles of unrecorded, corroding drums, and then there are the roads around Raleigh [whose shoulders have been contaminated with polychlorinated biphenyls]. There are carefully constructed, lined, covered, fenced in, and monitored basins, and then there are country ponds contaminated with industrial wastes, such as a DDT-contaminated pond near Triana, Alabama." A dump may contain one chemical predominantly, or it may contain tens or hundreds of major chemicals and literally countless minor ones.

It may be possible to draw analogies among dump sites, says William W. Lowrance of Rockefeller University, but "chemical, geological, or medical generalizations not based on site-specific analyses should always be considered unreliable." A corollary to this axiom is that it is virtually useless to combine statistical health data from groups of individuals exposed at different sites.

The primary route of human exposure to waste chemicals is usually assumed to be through ground water. Ground water furnishes about half of all U.S. drinking water, according to David W. Miller of Geraghty & Miller, Inc., of Syosset, New York, who spoke at the Rockefeller symposium. More than 40 million people depend on untreated domestic well water, many of them in urban areas. Impingement of hazardous chemicals on these water supplies is thus of great concern. Proximity to water supplies serving large numbers of people is, in fact, one of the primary criteria by which the Mitre Corporation, of McLean, Virginia, compiled the list of 115 most hazardous dump sites for EPA. Sixteen of the sites on the EPA list, for example, are in Florida, reflecting that state's great dependence on ground water.

Not all of the contaminants in water supplies come from dumped or improperly stored industrial wastes. Many household products contain organic chemicals that eventually find their way into the water supply. Pesticides are also a frequent contaminant, as are fertilizers and solvents used in garages, print shops, and dry-cleaning facilities. These chemicals can mask the presence of chemicals that escape from a dump or distort their apparent concentrations.

> "Chemical, geological, or medical generalizations not based on site-specific analyses should always be considered unreliable."

Cleanup of an aquifer that has been contaminated by organic chemicals, says Miller, is almost never physically or economically feasible. Strong consideration might thus be given to dedicating badly contaminated aquifers as waste disposal sites: such a scheme has already been adopted in one region in West Germany. Conversely, greater emphasis should also be placed on protecting aquifers that have not yet been polluted.

Fortunately, Miller says, most groundwater contamination incidents are local phenomena affecting only the uppermost aquifers. The typical contaminated area is less than a mile long and half a mile wide. Despite the fact that many chemicals in water are extremely mobile, the average rate of movement of the pollutants is about 1 foot per day. Depending on the hydrogeological characteristic of the area, adds Philip J. Landrigan of the National Institute for Occupational Safety and Health, the pollutants can often follow a rather tortuous path. Epidemiologists, he said at the Research Triangle Park meeting, must thus recognize that individuals who live closest to the dump or spill site are not necessarily those who receive the greatest exposure, and there must be extensive monitoring of the path of the pollutants.

Typical costs for determining groundwater quality at an industrial waste disposal site can range from $50,000 to $250,000. These efforts, however, give only an estimation of the extent of contamination and the rate of its movement. Plume shapes, lengths, rates of movement, and concentrations over time cannot always be predicted accurately, even with extensive study. In general, concludes Miller the monitoring industry is in its infancy. There is no consensus on drilling methods, sampling frequency or protocol, standard quality assurance procedures, or the number of wells needed to define problems. Many drillers are also unfamiliar with the specific techniques required for working with hazardous wastes, and they run the risk of contaminating clean aquifers while drilling into polluted ones. And finally, there is no legal framework for facilitating access to areas where wells must be drilled and for protecting investigators from liabilities associated with the assessment.

Contaminated water is not the only problem, of course. At Love Canal, for instance, the principal sources of exposure were volatile chemicals in the air and physical contact with contaminated soil. Technology for analyzing chemicals in such samples is adequate, but there is still the problem of deciding where to monitor. An even bigger problem is deciding what to look for when the contents of the dump are not known. The need to analyze multiple samples of air, soil, and water for a multitude of chemicals can overwhelm laboratory facilities, says Robert D. Stephens of the California Department of Health Services. In general, he contends, the private testing industry in this country is simply too small to deal with the uncontrolled waste site problem. There must thus be a strong effort to develop priorities both to limit the number of chemicals to be studied and to minimize the number of samples required.

Those analyses that are performed may be misleading. Quality control at many private and governmental laboratories is poor, says John A. Liddle of CDC, and reported results may be inaccurate. CDC has, for example, been monitoring interlaboratory comparability among some 100 laboratories that have been participating in a nationwide screening program for lead poisoning. Each month, CDC sends each laboratory three samples of blood from cows fed varying amounts of lead nitrate. When CDC started the program in 1974, Liddle says, only 35 percent of the laboratories got correct values (within 15 percent) for more than 70 percent of the samples. After an intensive training program at CDC and much work, about 65 percent of the laboratories now get more than 70 percent of the determinations correct. It is clear, however, that the laboratories are putting special emphasis on the CDC samples. When identical samples are sent to the laboratories from a disguised source, the number getting more than 70 percent of the answers correct drops by half.

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* A. D. Bloom, Ed., *Guidelines for Studies of Human Populations Exposed to Mutagenic and Reproductive Hazards* (March of Dimes Birth Defects Foundation, White Plains, N.Y., 1981); W. W. Lowrance, Ed., *Assessment of Health Effects at Chemical Disposal Sites* (The Rockefeller University, New York, N.Y., 1981); "Research Needs for Evaluation of Health Effects of Toxic Chemical Waste Dumps," symposium sponsored by the National Institute of Environmental Health Sciences, held at Research Triangle Park, North Carolina, 27–28 October 1981.

"The private testing industry is simply too small to deal with the uncontrolled waste site problem."

CDC recently began a similar study with polychlorinated biphenyls (PCB's) in cow's blood, but only about half of the state laboratories and only five of the 114 largest private laboratories invited to participate did so—"They can't be convinced that we are nonregulatory," says Liddle. The samples were spiked with other halogenated hydrocarbons commonly found in humans so that they represented "the worst case" that the laboratories might encounter. Only three of the 29 participating laboratories produced values of PCB concentrations that were within 2 standard deviations of the correct value. Both lead and PCB's are compounds that have been studied for a long time and should be readily measurable, Liddle says; the implication is that results may be much worse for other chemicals with which there is less experience. There is a "desperate need" for more work on interlaboratory comparability, he concludes, so that it will be possible to believe published results and accurately relate them to health effects.

Even when the concentration of contaminants in air, water, and soil is known, it is still difficult to determine whether humans have been exposed to them and, if so, at what concentrations and for how long. "The only objective measures of this so far," says Heath, are for chemicals that collect and persist in the body, particularly chlorinated aromatics such as PCB's and pesticides. Even for these, it is necessary to know baseline levels in the population at large before the extent of exposure can be determined. In some cases, those baseline concentrations are quite high.

One of the few sources of such information is the Health and Nutrition Examination Survey (HANES) conducted by the National Center for Health Statistics. For HANES, physical examinations were conducted on more than 15,000 people, ages 12 to 74, at 64 locations throughout the country. As part of the survey, says study director Robert S. Murphy, blood and urine samples from many of the participants were examined for pesticides and related chemicals.

Among some 6000 subjects whose blood was examined, more than 99 percent had significant quantities of DDT. The proportion with other halogenated pesticides in their blood ranged from 4 to 14 percent. Among some 4000 individuals whose urine was examined, 79 percent had significant quantities of the pesticide-related compound pentachlorophenol. Other halogenated intermediates were present in 4 to 7 percent of the samples, carbamate pesticides were present in 2 to 4 percent of samples, and organophosphate pesticides were present in 6 to 12 percent.

The center has also conducted a Human Adipose Tissue Survey, says Murphy, in which samples of fat were obtained from cooperating pathologists. Some 93 percent of 785 samples contained significant quantities of the pesticides DDT, chlordane, and dieldrin, as well as hexachlorobenzene. A third of the samples also contained PCB's.

Other studies have shown significant regional variations. A survey in the Southeastern United States showed that 23 percent of the individuals studied had trace levels of the potent carcinogen aflatoxin in their blood, according to Renate Kimbrough of CDC; aflatoxin is produced by a microorganism that grows on peanuts. Studies in Michigan show that 99 percent of individuals in the lower peninsula and 85 percent in the upper peninsula show significant quantities of polybrominated biphenyls in their adi-

Battelle's Columbus Laboratories

Some dump sites are obvious . . .

Piles of corroding barrels may or may not represent a hazard, depending on their contents and location.

pose tissue, according to Mary Wolff of the Mt. Sinai School of Medicine in New York City. Polybrominated biphenyls were inadvertently mixed with animal food in the state in the early 1970's. Interestingly, the chemicals were found in blood serum in 78 percent of individuals from the lower peninsula, but in only 19 percent of those from the upper peninsula.

No one knows what other chemicals might be found in human fat, largely because there has been no organized program to search for them and no consensus on what to look for. And, says Wolff, there is no consensus on whether adipose tissue is the best place to look for organic chemicals. The most severe limitation, obviously, is that collection of adipose tissue samples requires minor surgery. Some chemicals such as Kepone and tetrabromobenzene, furthermore, do not partition to a great extent into fat, Wolff says. Also, levels of chemicals in adipose tissue are lower in women than in men, presumably reflecting a dilution resulting from women's higher fat content.

A potentially better monitoring tool is human milk, which contains about 3 percent fat, and thus should have higher levels of fat-soluble chemicals than blood or urine. Samples of human milk throughout the United States generally contain DDT, DDE, PCB's, dieldrin, and heptachlor epoxide, says Walter J. Rogan of the National Institute of Environmental Health Sciences, and there is a wide geographic variation in observed concentrations. Any monitoring use will thus require extensive baseline studies with controls.

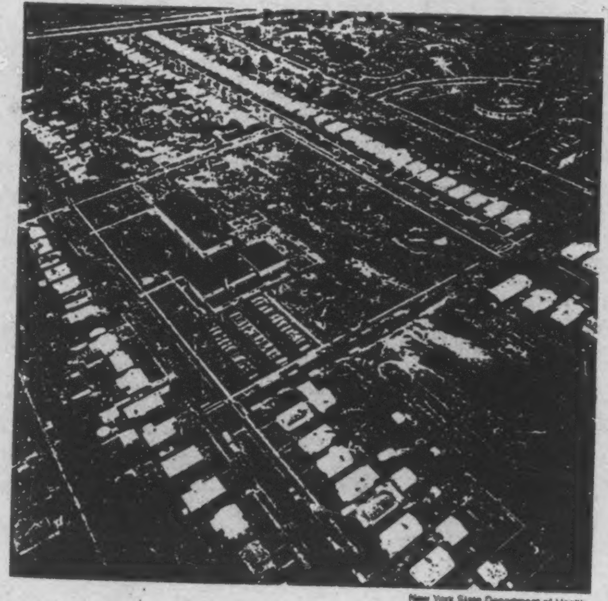
The presence of chemicals in milk is not restricted to the United States, he adds. "It is unusual to find uncontaminated milk anywhere in the world." Collection of milk samples also presents problems. Lactating women are a very small subgroup with a narrow range of ages and may not be representative of exposure among the population at large. Many women who are asked also refuse to participate, says Rogan. And finally, contamination occurs very easily during collection of the samples.

One potential new way to study exposure to the same types of chemicals, says Wolff, is to measure their concentration in skin oils. Limited studies have shown that their concentration in skin oils is proportional to the concentrations in serum and adipose tissue—with the notable exception of individuals who work with PCB's and have very high concentrations of these chemicals in their skin oil. This approach is particularly susceptible to contamination of samples during collection, however, and a great deal more work will be required to establish its validity.

Another potentially useful monitoring technique is the study of hair, says Thomas Clarkson of the University of Rochester. Metals, especially, collect in hair and analysis can provide a good indicator of recent exposures (*Science*, 22 December 1978, p. 1271). Unfortunately, most suspected exposures do not involve metals. There is some evidence that organic chemicals also accumulate in hair, but this aspect requires much further work for verification.

Other ways to monitor exposure to toxic chemicals involve a direct assessment of health effects, including reproductive effects and chromosomal abnormalities. (These will be the subject of a second article.) Estimating the toxicity of the chemicals present at a dump site is another important problem in this area (*Science*, 29 September 1978, p. 1200; 6 October 1978, p. 37). That this problem has not yet been adequately resolved is illustrated by the dispute between OTA and EPA.

The main problem with the EPA listing of hazardous waste sites, says Joel Hirschhorn of OTA, is that it does not give sufficient weight to the degree of toxicity of chemicals in a dump or waste disposal site. Instead, the model used for the ranking gives greatest weight to the number of people close to the site who are at risk of exposure. OTA argues that a dump which exposes a small number of people to an exceptionally hazardous compound is more dangerous than one that exposes larger numbers to more innocuous chemicals. The agency argues in favor of "a well-designed degree-of-hazard classification system" which would provide a more cost-effective way to manage industrial wastes. EPA, in turn, argues that the data simply do not now exist to establish degrees of hazard, particularly when trace quantities are involved. Until better data are provided, presumably by epidemiologists studying exposures, the agency will continue to assume that most hazardous wastes are created equal.—THOMAS H. MAUGH II



New York State Department of Health

. . . and some are not

This infrared photograph of the Love Canal area, taken before any residents were moved from the area, shows vegetation killed by escaping chemicals as white areas across the road from the school.

Chromosome Damage: What It Is, What It Means

Chromosome damage is an important test of whether people have been exposed to toxic chemicals. But the test is hard to interpret. Some damage occurs naturally because of such things as colds, flu, x-rays, and sunlight, and damage also increases as a person ages. People who have come into contact with a toxic substance, however, may have more damage than a comparable group that has not been so exposed.

Excess damage in a population may have some meaning but on an individual basis it does not. On the average, a population with damaged chromosomes may have more cancer and more birth defects than otherwise expected, but the individuals in the population whose chromosomes are damaged are not necessarily those who will suffer these ill effects. Chromosome damage is just an indicator, a sign that the population may have been exposed to something that damages DNA. Many of the substances that cause chromosomal aberrations are also thought to cause cancer and birth defects. But the white blood cells sampled for a test of chromosome damage are not themselves likely to give rise to cancer, and they cannot contribute to birth defects because they are neither sperm nor egg cells.

The assessment of chromosome damage is as much an art as a science. White blood cells must be carefully cultured, then stained and examined under the microscope. The 46 chromosomes in a human cell can be individually identified by their characteristic shapes and sizes. If there is damage, it often appears as breaks and deletions or as rings, which are formed from chromosome fragments. Cells with damaged chromosomes usually die or repair the damage.

Although the chromosomes are the carriers of genes, almost never can specific chromosomal aberrations be associated with specific birth defects or cancer. One exception is Down's syndrome, in which individuals inherit an extra chromosome 21 and this extra chromosome shows up in all their cells. But most genetic defects and most DNA damage that may lead to cancer involve submicroscopic changes in DNA and quite often do not lead to physical changes in the chromosomes. There is only indirect evidence associating chromosome damage with birth defects and cancer.

Perhaps the best evidence correlating damaged chromosomes with an increased incidence of cancer comes from the survivors of Hiroshima and Nagasaki. They had a significant amount of chromosome damage, which was directly related to the dose of radiation they had recieved. Moreover, the more radiation they were exposed to, the greater their incidence of cancer. But even in that population, those with the greatest amount of chromosome damage were not necessarily those who got cancer.

Among the Hiroshima and Nagasaki survivors, there was no statistically significant increase in birth defects and miscarriages. Ionizing radiation is known to cause birth defects and miscarriages, but the normal rate of these incidents is so high that it is very hard to show a significant increase, especially in a small population, according to Jean French of the Center for Disease Control. Nearly 11 percent of all children born have genetic defects, and as many as 50 percent of all pregnancies are estimated to end in a spontaneous abortion.

"It's a scary thing to tell people they have chromosome breaks," says Arthur Bloom of Columbia University. "But the breaks are by no means a harbinger of cancer or birth defects."—GINA BARI KOLATA

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Biological Markers for Chemical Exposure

Effects on reproduction and chromosomes may be the best indicators of exposure to chemicals in dumps, but the health effects are uncertain

When the cap on the chemical wastes storage site at Love Canal was disrupted by construction activities, toxic chemicals leaked to the surface of the soil and into the basements of nearby homes. It was a relatively easy matter to identify the principal chemicals present and to measure their concentrations. It was far more difficult to determine which residents of the area, if any, had been exposed to the chemicals and, if so, to which ones and for how long. Even today, that determination has still not been made to anyone's satisfaction.

The problem is not restricted to Love Canal; it is common to all hazardous waste storage and dump sites. Even when it is known that toxic chemicals are present in air or water, it is still difficult to obtain an objective measure of the extent of exposure. Serum and urine analysis are frequently of limited value because most chemicals are cleared from these fluids rather quickly. Analysis of adipose tissue, human milk, and hair can be of use in documenting exposure to chemicals that are fat-soluble. What is needed is a more general indicator of exposure, ideally one that does not require analysis of specific chemicals.

Three recent meetings were convened* to consider the problems associated with hazard waste storage and dump sites and to evaluate ways to monitor exposure to toxic substances (*Science*, 29 January, p. 490). Among the chief subjects of concern were chromosomal damage, reproductive alterations, and neurotoxic effects of exposure. The consensus seems to be that these deviations can provide ways to monitor chemical exposure, but that it is extremely difficult to relate that exposure to long-term health effects.

One possible way to assess exposure to toxic chemicals is to study chromosome aberrations and sister chromatid exchanges. Chromosome aberrations involve breaks in whole chromosomes during the stage of growth that precedes replication. The pieces may then be rejoined (correctly or incorrectly), remain broken, or be lost. For each case, except a correct rejoin, the damage can be ascertained by visual examination under a microscope. Such observations are most commonly made in white blood cells because they are easy to obtain.

Part two of two parts.

Radiation-induced chromosomal aberrations have been recognized since the early 1950's. Inadvertent exposure of some workers to high doses of radiation has led to much information about dose-response relationships. In general, the number of radiation-induced aberrations that involves breakage of only one chromosome increases linearly with dose, whereas those that require breakage of two (to produce translocations, inversions, rings, and the more commonly studied dicentrics) increase approximately as the square of the dose. Chemical mutagens can produce similar effects, Sheldon Wolff of the University of California at San Francisco told the Rockefeller symposium, but "dosimetric problems become formidable. Neither the concentration of chemicals within cells nor the biological or chemical lifetimes are known with any certainty." Knowledge regarding diffusibility or active transport of chemicals into the cells in question is also limited.

The major problem with assessment of chromosome aberrations is getting statistically significant results for low dosages. Even after the relatively high radiation dose of 10 rads, for example, Wolff says that 300 cells would contain an average of less than one dicentric. "One would have to study an extremely large number of cells to observe a statistically significant increase." The number of aberrations produced by chemicals, some experiments suggest, will be smaller; if the exposure occurs over a long period, the number of aberrations will be further reduced by repair mechanisms.

Great care must be taken in assessing the significance of an increased number of abnormalities. "Even when one does see some aberrations," says Wolff, "it is difficult to say with any certainty that the aberrations were induced by the given exposure, because people are exposed to many other agents, such as medical and dental x-rays, caffeine, viruses, and other environmental pollutants, that can break chromosomes. This also raises difficulties in defining proper reference populations."

Wolff frequently cites the cautionary example of a radiation therapist who was exposed to excessive radiation when an x-ray machine failed to shut off while he was setting the machine for the next patient. "In 500 lymphocytes we found three dicentrics, which was certainly disconcerting. However, we also examined blood from the physician's partner, a diagnostic radiologist not exposed in the accident. The 'unexposed' partner had four dicentrics in 200 cells."

An increased number of chromosome aberrations believed to be associated with radiation exposure has been observed in atomic submarine refuelers in Britain. Relatively high doses of radiation, however, were required to produce observable numbers, the results were highly variable, and a worker whose sample showed an aberration on one occasion might have none later.

The health significance of such abnormalities is still questionable. Most aberrations that can be observed are actively selected against and are generally not passed on to daughter cells because they prevent cell division or because they lack a large number of necessary genes. "As a group, however," notes Wolff, "the exposed cells will have other [nonvisible] chromosomal changes, as well as point mutations. Therefore, the presence of aberrations can be used to signify a potential problem in the population, but quantifying the abnormalities in the seemingly normal cells is extremely difficult."

Support for this conclusion can be found in studies of Japanese who survived the atomic bombing of Hiroshima and Nagasaki. These studies show that, as the exposure increased, the number of chromosome aberrations and the incidence of cancer also increased. Adds Wolff: "The individuals with the aberrations, however, were not necessarily those who developed cancers."

The discovery of chromosomal aberra-

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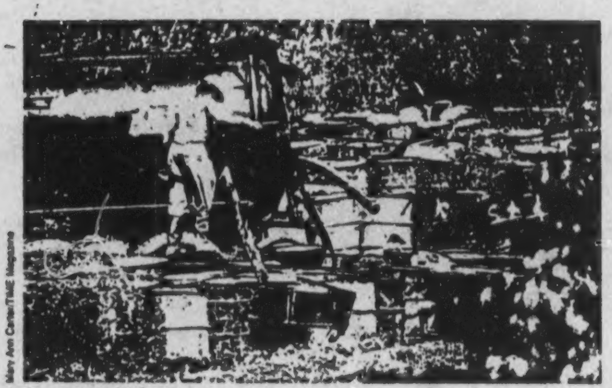

Mary Ann Carter/TIME Magazine

At greatest risk?

Workers who clean up dump sites may be the best subjects to study because they have the highest risk of exposure.

tions can thus introduce an ethical quandary. "What," asks Renate Kimbrough of the Centers for Disease Control, "do you tell the patient in whom such an observation has been made? Do you tell him that he'll get cancer in 20 years?" Scientists such as those investigating the Love Canal situation have been very insensitive about such problems, says Adeline Levine of the State University of New York at Buffalo. They have failed to recognize the impact of their findings on the morale and psychological well-being of the residents—to the point where many of the residents will no longer cooperate with investigations.

Another chromosomal abnormality that can potentially be used for assessing exposure is the sister chromatid exchange (SCE). These are exchanges of genetic material between complementary chromatids that have been made chemically different from one another (typically by treatment with bromodeoxyuridine) and thus differentially stainable. (Chromatids are identical chromosomes attached to the centromere during replication of DNA.) Such exchanges are readily visible under a microscope. They are also a more sensitive indicator of exposure, often showing significant increases in numbers at chemical doses a hundredth as large as those necessary to increase the yield of aberrations.

"The relation of SCE's to ill health, however, is even more tenuous than it is for chromosome aberrations," says Wolff. A March of Dimes panel chaired by Arthur D. Bloom of the Columbia University College of Physicians and Surgeons and Anthony V. Carrano of Lawrence Livermore National Laboratory notes that SCE's "are not, as far as we know, mutational events, in the strict sense. We are aware of no health consequences of SCE's per se." The main argument for use of SCE's for monitoring exposure to chemicals is the fact that many mutagens and carcinogens induce SCE's in cultured cells.

In attempts to monitor people exposed to suspect toxic chemicals, Wolff says, investigators have found only very few compounds that elevate the mean number of SCE's above that of reference populations. Those studies showing an increase in SCE's include laboratory workers carrying out hormone analyses and organic chemical research, nurses handling cytostatic compounds, and hospital workers exposed to the sterilant ethylene oxide. The elevated numbers of SCE's in these populations, however, were high only in comparison to nonsmoking controls: the smoking control population for the study of laboratory workers, for instance, had the same average number of SCE's as the population of smoking and nonsmoking exposed individuals. In conclusion, the Bloom-Carrano panel argues, "SCE studies in human populations are likely to prove to be a sensitive measure of exposure to chemical mutagens, but such studies are in their formative, or developmental stages, and must be interpreted with caution." Meanwhile, more work needs to be done on ways to identify mutations directly.

If it is not possible to monitor exposure directly, it may be necessary to infer exposure from studies of health effects. The most common approach to assessing exposure is the study of reproductive dysfunctions, including impotence, sterility, fetal loss, stillbirth, low birth weight, birth defects, and infant illness and mortality. Reproductive effects were a special focus of the March of Dimes meeting, and were considered by a panel chaired by Dorothy Warburton and Zena Stein of the Columbia University College of Physicians and Surgeons.

Impotence and sterility or infertility are generally not easily studied measures of reproductive dysfunction, says Warburton, except in the most unusual cases. Their incidence in the population is rather high and there are many confounding variables in coital and contraceptive practices and in the unrecognized or unreported loss of fetuses. Only when the health effects are striking, as was the case with kepone workers in Virginia and dibromochloropropane workers in California, do any of these become a worthwhile indicator.

Sperm studies are appealing, says Warburton, "because they offer the most direct look possible at the products of gametogenesis." Semen abnormalities are often analyzed, but the panel's consensus was that although these may represent indicators of exposure, their significance for reproductive function is largely unknown. Even among fertile men, sperm numbers and ejaculate volumes vary greatly, as may sperm motility. Single samples are insufficiently representative and, in populations under study, as many as half the men asked will refuse to provide specimens.

When the frequency of abnormalities is sufficiently unusual, sperm morphology (structure) can be useful, says Warburton, but "it is subject to great variation among observers, even with attempts to standardize classification schemes." It is known, moreover, that some men with abnormally low sperm counts or with large numbers of morphologically abnormal sperm are fertile, while other men with normal sperm are infertile. And finally, she says, there is little evidence for or against an association between sperm abnormalities and undesirable outcomes such as spontaneous abortions or birth defects.

The study of abnormal morphology is more sensitive than sperm counts though, argued Andrew Wyrobeck of the Lawrence Livermore National Laboratory at the Research Triangle Park symposium. A 25 percent change in the frequency of abnormalities can be detected with only 26 men, whereas a similar change in the number of sperm requires 200 men for detection. Studies of sperm abnormalities have been useful in certain cases, he adds. When investigators suspected unusual exposures of workers involved in production of the pesticide carbaryl, for example, sperm counts were normal but there was a significant increase in the number of abnormalities. Wyrobeck further notes that there is normally very little difference in sperm counts or number of abnormalities over the course of an individual's lifetime, so that studies of individuals for long periods should provide a more effective indicator of exposure.

Spontaneous abortions, defined as termination of pregnancy before 28 weeks of gestation, may be a better indicator of reproductive dysfunction and exposure to toxic substances. "About 90 percent of chromosome aberrations [in germinal cells] are lost as the result of spontaneous abortions," says Warburton, "and about 50 percent of all pregnancies with malformations" are similarly lost. In normal populations, at least 15 percent of all recognized pregnancies are spontaneously lost, and the number in unrecognized pregnancies may be much higher. This high rate, like that of sperm abnormalities, makes spontaneous abortions a potentially sensitive indicator. A doubling in the rate of occurrence of a rare event, for example, is much more likely to occur by chance than a smaller increase in the rate of a more common event. Spontaneous abortions also have the advantage of providing a specimen that can be examined in various ways to provide information about the mechanism of loss, including chromosomal analysis and detailed morphological classification of defects.

There are also disadvantages. The only sources of available data are medical records and personal interviews. Medical records are insufficient because a large number of spontaneous abortions are not brought to medical attention, while interview data are subject to recall bias and to inaccuracies of self-diagnosis. Chromosomal and pathological examination of the abortus is also expensive.

Increases in the rate of spontaneous abortions have been reported among female anesthesiologists in England and the United States, in the wives of individuals who work with vinyl chloride, and in women near Alsea, Oregon, and at Love Canal exposed to the herbicide 2,4,5-T. The Warburton-Stein panel concluded, however, that each of these studies has serious deficiencies that make the data suspect. The studies of anesthesiol-

The Dump That Wasn't There

There is perhaps no better example of the difficulties in linking health effects to hazardous waste storage and dump sites than the so-called "ghost dump" in the Frayser neighborhood of Memphis, Tennessee. The situation that occurred at Frayser is also a good example of the perils of relying on residents' reporting of an increased incidence of health effects.

Frayser is a blue-collar residential neighborhood surrounding Steele Street in the northern suburbs of Memphis, not far from the Mississippi River. Memphis has a large chemical manufacturing industry, but none of the plants are in the immediate vicinity of Frayser. In August of 1976, Mrs. Evonda Pounds of Frayser called the Memphis and Shelby County Health Department to complain of rashes and other minor illnesses, arguing that she and her family were being poisoned by toxic chemicals in the environment. An investigation of her home and yard disclosed only trace concentrations of chlordane and other pesticides that are used in Memphis to control termites and mosquitoes.

Mrs. Pounds called again the next year, with the same complaints and the same results. And the next year. By the summer of 1979, other residents of the neighborhood had begun to complain of an increased incidence of rashes, headaches, urinary problems, heart disease, and cancer. One former health department employee claimed that he knew the location of a chemical waste dump in the area, says Charles Konigsberg, director of the Memphis and Shelby County Health Department. By the following April, he says, there was a "highly charged atmosphere," virtually identical to that at Love Canal: the citizens "panicked" and there was picketing and emotional meetings were held. There was even talk of evacuating the area. A local political activist pressed for immediate action in the area, and Representative Albert Gore, Jr. (D-Tenn.), held congressional hearings about the reputed dump, even though Frayser is not in his district.

Meanwhile, the U.S. Environmental Protection Agency (EPA) had begun analyzing air, water, and soil samples from the entire neighborhood. According to Jeff Harris of the Tennessee Department of Public Health, they found "absolutely nothing higher than background levels of pesticides." Working with EPA, epidemiologist Morton Korn of Johns Hopkins University went through old records covering the Frayser area, examined aerial photographs taken in the neighborhood since development began after World War II, and conducted other studies. Says Harris: "They found no obvious source of chemicals."

During the same period, the U.S. Centers for Disease Control (CDC) conducted a door-to-door survey of some 300 homes in the neighborhood asking about health effects, examined physicians' records, and so forth. This survey, according to Henry Falk of CDC, "did not produce any evidence of toxic illness or severe health effects." There was a slightly increased incidence of headaches and skin rashes, but the latter were of several different types and it is "unlikely that they were chemically caused." One man was found who had heavy metal poisoning, but he works in a foundry where the metal is present. One of Mrs. Pounds' children was found to have hives. CDC "took a long time" to publish their findings, says Konigsberg, and when they finally were released some 14 months ago, "nobody believed any agency."

About that same time, Memphis authorities became aware of the North Hollywood Street dump site some 3 to 4 miles away from the Frayser neighborhood—and separated by several physical barriers so that there is no chance of any chemicals from it having reached Frayser. The Hollywood site is a known waste storage area whose contents have been identified, and federal and local agencies shifted their investigations from Frayser to the more immediate hazard. "There are about half a dozen people in Frayser who still believe they have unusual health problems," says Konigsberg, but the uproar and the outrage have largely subsided. But the specter of this ghost dump will continue to haunt epidemiologists confronted with other self-reported increases in illness.—T.H.M.

ogists were based on questionnaires that could be biased if the frequency of abortions was higher among those individuals who replied than among those who did not. The vinyl chloride studies were based on husbands' recall of their wives' miscarriages, an approach that is considered unreliable. The Alsea studies were based on women hospitalized for spontaneous abortions, and there was no study of hospitalization rates among controls. Finally, the Love Canal study used inappropriate control data, collected 10 years previously from a different population.

Birth defects are much less common, occurring in only 2 to 3 percent of live births. This is the reproductive outcome that is most distressing to families and to society; it is also the most visible outcome, and thus the outcome most likely to be self-reported by the community as being increased. Anomalous fetal development, however, can have a great many causes, both genetic and physical, and can take a wide variety of physical manifestations. Until very recently, there have been no systematic records of malformations and little agreement about how to classify them.

Identification of a consistent pattern of malformations as a result of exposure to a particular agent is convincing evidence of a real effect, says Warburton, but it is also possible for the effects resulting from a single exposure to vary, depending on the time of exposure and the dose. In the case of chemical dump sites, where multiple agents are involved, the effects could be so varied that it will prove almost impossible to demonstrate any linkage. An increased incidence of birth defects, in fact, has not been convincingly demonstrated at any waste storage site. In the United States, the panel concludes, the necessary baseline information on spontaneous abortions and birth defects has not been developed on a sufficient scale, and should be vigorously pursued.

Birth weight of the offspring is another potential indicator of maternal health. About 7 percent of American infants weigh less than 2500 grams at birth. Low birth weight is the most important contributor to infant mortality, and is strongly related to congenital malformations, developmental delay, and chromosomal abnormalities. One of its chief advantages as a diagnostic tool is that birth weights are routinely recorded on birth certificates and hospital records in most parts of the world, and the data are not subject to biases of reporting.

For this reason, says Warburton, the reported increase in the number of low birth weight babies is the most convincing reproductive effect described at Love Canal and from the areas surrounding lead smelters in Sweden. But maternal age, race, alcohol consumption, and smoking habits are also risk factors for low birth weight. Gestational age should also be determined to distinguish between those infants born small due to prematurity and those born small due to poor fetal growth.

One type of assay for which the health effects are more predictable is neurotoxicological examination. Neurotoxic illness is generally diffuse; degeneration may occur in neurons, in their myelin sheaths, or in nerve junctions throughout the body. Neurotoxic impairment may thus produce a wide variety of clinical symptoms. Furthermore, says Herbert H. Schaumburg of the Albert Einstein College of Medicine, "subclinical impairment of the nervous system is prevalent" throughout the population without being noticed; further impairment is not recognized unless it is substantial.

Chemicals tend to exert their effects on the nervous system immediately rather than after a latent period. The manifestation of the symptoms may depend dramatically on the dose and the length of exposure. Massive doses of acrylamide, for example, produce convulsions, hallucinations, and encephalopathy, whereas mild exposure can cause peripheral nerve damage and blindness. One chemical, furthermore, can often potentiate the neurotoxic effect of a second.

Studies of potential neurotoxic effects have been conducted at many dump sites by a technique called nerve conductivity measurement. In this approach, a nerve (such as one of the long nerves of the leg) is stimulated at its upper end and the investigator measures the time lapse before the innervated muscle twitches. Presumably, a lengthening of the delay time represents nerve damage. The test is performed because it is easy, but Schaumburg does not think it is very discriminating: "I think it's an abominable test for most toxic neuropathy. By the time nerve conduction fails, you've got a badly damaged patient. Also, the test has to be done in the hands of a master, and it has to be very carefully standardized." He argues that some 90 percent of published studies in which the technique is used are suspect for one reason or another, and that many chemicals have been falsely labeled as neurotoxins because of its use.

He holds more hope for such newer techniques as evoked potential measurements (in which brain electrical activity is measured after other parts of the body have been stimulated), and for newer, noninvasive imaging procedures such as positron emission tomography and nuclear magnetic resonance spectrometry, which can monitor metabolic activity in the brain.

Echoing other investigators, Schaumburg says there is a "desperate need for neurodiagnostic technology" that can be applied by technicians to assess possible damage. There is also a need for animal tests that can identify potential neurotoxins. "Too often," he says, "the only test animal we have is man himself." Society has been lucky so far, he says, that there have not been any serious outbreaks of neurotoxicity at dump sites. There have been problems in industry, however, and it seems inevitable that new problems will be identified as the diagnostic technology improves.

Apart from certain neurotoxic effects—and obvious cases of outright poisoning—any health effects that result from hazardous waste storage or disposal sites will most likely be subtle and hard to detect. They will tend to be long-term and may remain asymptomatic and subclinical (undetected by routine physician or self-examination), possibly through long latent periods. Illnesses that do arise from chemical exposures, furthermore, can be expected usually to resemble or be identical to the conventional health problems in a community, such as cancer, miscarriage, and nerve damage—what Robert Goyer of the National Institute of Environmental Health Sciences terms "the most feared diseases."

One of the few areas on which agreement can be reached by nearly everyone is that such diseases can be detected only by long-term monitoring of populations at risk. So far, however, there are few such studies and limited funds to support them. One prototype study is being conducted by Harold Humphrey of the Michigan Department of Public Health. The department is monitoring 4000 Michigan residents who were exposed to polybrominated biphenyls in the early 1970's and 1600 Iowans who serve as a control population. The study is expected to continue for at least 15 years and should serve as a useful example of the effects of exposure to chemicals.

Another, more germane study is being initiated by Ruth Lilis of the Mt. Sinai School of Medicine in New York and Donald Henry of At-Sea Incineration, Inc., of Greenwich, Connecticut. They will monitor the health of workers aboard the ship that At-Sea will use to incinerate toxic wastes at sea. Many investigators think this will provide the best approach to monitoring health effects, since individuals who dispose of toxic wastes are the most likely to have significant exposures. Lilis recommends that similar studies be initiated to monitor the health of workers who clean up dumps on land.

Refining these techniques for monitoring exposure and determining health effects, says James V. Neel of the University of Michigan, "is not an academic exercise but one of the two or three most important challenges to biomedicine in the next decade. Decisions entailing billions of dollars are involved. In this connection, I must once again chide many of my . . . colleagues for talking big but thinking small. We have spoken copiously of the possible risk to future generations of environmental contaminants, but, in my opinion, have thus far failed either to formulate or request funds to pursue proper epidemiologic studies. Hopefully, [these conferences] will be seen in retrospect as the occasions when [scientists] . . . first laid out to Government what had to be done in the nation's interest."

—Thomas H. Maugh II

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environment

Distrust leaches out over Stringfellow studies

For more than three years, homeowners in Glen Avon, Calif., have complained that health officials downplayed their worries about hazardous waste seeping from the nearby Stringfellow Acid Pits. Now the Riverside County Dept. of Health is sending interviewers around with a 150-item questionnaire that is hoped to establish some epidemiological patterns. But residents are far from satisfied. They say the effort is too little, too late.

The Glen Avon controversy may be a harbinger of future dilemmas for officials trying to balance the need for health data with the availability of scientific and financial resources. Although Glen Avon residents have called for full-scale health studies for some time, getting funding for such studies has been an uphill battle.

At issue in Glen Avon is whether heavy metals, chlorinated organics, and other known or suspected carcinogens dumped at Stringfellow have contaminated the community's groundwater and caused health problems for residents. The town sits some 2 mi below the Stringfellow site, which was closed in 1972 by a court order following 16 years of operation. Heavy rains caused the pits to overflow again last winter.

Hard to estimate. "You've got to be an idiot not to be worried about cancer," says Jan A. Newman, head of Concerned Neighbors in Action, a group of 2,500 Glen Avon residents. Robert C. Fontaine, a long-time community resident, says he "gets five more grey hairs" every time he hears about another possible carcinogen leaching out of Stringfellow.

Outside health experts also express concern. "It's difficult to even estimate the size of the problem," says Robert D. Stephens, former deputy director of the Toxic Substances Control Div. of the state Dept. of Health and Welfare.

In mid-1980, county officials asked the Environmental Protection Agency for $1 million for a five-year study of 1,500 residents of the area. That request, and another in February 1981, were both rejected. "EPA does not fund this type of study regardless of the amount of money requested," says a spokeman for the agency's San Francisco office.

Little help was forthcoming from the 224 companies that generated or dumped the wastes at Stringfellow, either. According to Patricia L. Shanks, a San Francisco lawyer who chairs an industry steering committee to negotiate cleanup costs with EPA, the companies have not been aware of any health problems in Glen Avon, and thus have felt no need to set up health surveys of their own. Moreover, Shanks says that even if surveys do show a higher rate of ailments in Glen Avon than in other communities, it is unlikely they would be sufficient "to determine the cause of any differences that might be found."

A 150-item epidemiological questionnaire, residents say, is overdue and inadequate

Not surprisingly, local activists have collected their own data. For example, in 1980 Concerned Neighbors began a door-to-door sampling of residents, and Newman says the results did not augur well for the community's health. "A lot of the children complained of headaches," she says, while adults spoke of urinary and respiratory ailments.

Another group, Parents of Jurupa (the Spanish spelling of an Indian word meaning "place of sagebrush"), has also harangued health officials for better tests. Although a county blood sampling of 23 area residents turned up no specific problems, the group continues to press for a comprehensive blood study of Glen Avon's children.

One shot. The eventual compromise seems to be satisfying no one. In 1982, the state allocated $150,000 to cover physical examinations of 150 Glen Avon children and a "one-shot" health study of 600 families in the area. The county hired Gary H. Spivey, an assistant professor of public health at the University of Southern California (Los Angeles), to design the study.

Spivey's survey involves one-to-two-hour home interviews with 300 families in Glen Avon, and with a control group of families in Rubidoux, a nearby community considered to be beyond the reach of any dump site effluent. Interviewers are asking family members about such symptoms as the frequency of headaches and the presence of any cysts or lumps. Women, due to concern

John Barr, Gamma/Liaison

Suspected carcinogens in the Stringfellow Acid Pits may have affected Glen Avon residents 2 mi away.

over possible effects of toxics on the reproductive system, are questioned about the regularity of their menstrual cycle.

The interviewers are being treated to a formidable recitation of ailments. Newman says she has respiratory problems, and one of her sons has constant headaches as well as muscular and neurological problems. Another son suffers from severe asthma, and had to have his gall bladder removed when he was six years old. Fontaine reports a nonmalignant bladder tumor, and his five children, ranging in age from 14 to 22, periodically complain of aches and pains in their joints. Three of his children have cysts, and Fontaine says he is worried that they may have suffered genetic damage that will affect their offspring.

Few scientists are willing to state with certainty that any single study can provide the type of reassurance that Glen Avon residents seek. Even Spivey concedes that there have been so few studies of this magnitude done on residents near abandoned waste dumps that, for now, no one can be certain the approach is correct.

Relative degrees. Although Spivey expects that his survey, which is scheduled for completion in late 1983, will serve as a model for future studies to measure the effects of toxic waste, he warns that fail-safe studies of health effects will probably never be developed. "There are no definite results in epidemiology, only relative degrees of certainty and uncertainty," he says.

County officials contend that residents are "reacting favorably" to the survey, but talks with Glen Avon citizens turn up a far more critical attitude. Newman, for one, charges that because the county did not involve the community in setting up the survey, some significant errors were made. For example, she insists that the geographical lines were drawn incorrectly, resulting in far too many Glen Avon residents—including her own family—winding up in the control group. "Their way of implementing this thing is ludicrous," she says. "It's been a total waste of $150,000."

To date, about 100 questionnaires have been completed. Herbert C. Holk, a Riverside County public health official, says the number is too small for even a preliminary health assessment. "If we come up with significant findings, then we will have to seek additional funding," Holk notes. If no such findings turn up, he says, there will be no further tests.

An 'awful' coincidence. Local residents are not waiting for the survey to be completed to continue their fight for monetary redress. They are pushing for a state-funded insurance program to handle medical bills arising from immediate health problems and from any that show up later.

And efforts to clean up Stringfellow may yet result in a fresh battle. Newman, who sarcastically calls the relationship between her family's ailments and the proximity of the abandoned dump "awfully coincidental," is pressing for a compensation fund that will pay expenses for residents who must evacuate the area if Stringfellow is not cleaned up to everyone's satisfaction. "If [the cleanup] doesn't work," says Newman, "we don't want to suffer any more from their mistakes." ◻

OTA criticizes EPA study of Love Canal

On 21 June, the Office of Technology Assessment (OTA) of the U.S. Congress released a study which criticizes the U.S. Environmental Protection Agency (EPA) two-year, $10-million monitoring study of off-site contamination near the Love Canal hazardous waste landfill in Niagara Falls, New York. (HMIR, 16 July 1982, p.1.) The study, which was originally requested by Senators Daniel Moynihan (Democrat-New York) and Alphonse D'Amato (Republican-New York), also criticizes the decision by the U.S. Department of Health and Human Services (HHS) to declare "habitable" a section of the neighborhood near the landfill. The OTA study concluded that there "remains a need" to demonstrate more unequivocally that the area declared habitable is in fact safe, and that otherwise, "it may be prudent to accept the original presumption that the area is not habitable."

EPA released the monitoring study in July 1982 as the largest and most expensive study ever conducted of a hazardous waste site. EPA based the study on nearly 7000 samples taken 21 months earlier from two areas at Love Canal: 1) Rings I and II, including the landfill and the 238 homes bordering it; and 2) the "Declaration Area," consisting of an additional 550 homes and a 250-unit cluster of apartment buildings. EPA concluded in its study that there was "selective" migration of toxic substances in the vicinity of certain areas of Ring I and that there was "no compelling evidence" that the environmental quality of the Declaration Area was "significantly different" from control areas throughout the U.S. As a result, EPA found that 90 percent of its data indicated that either no toxic chemicals or only trace amounts of toxic chemicals were present in the Declaration Area. OTA reexamined EPA's data for 16 chemicals known to be at Love Canal and found that four of these, 1,2- and 1,3-dichlorobenzene, and 2- and 4-chlorotoluene, were present in levels significantly higher than those found in EPA's control areas.

- **HHS's "habitability" decision.** OTA found that EPA's data did not support HHS's decision that the Declaration Area was habitable, and OTA criticized HHS for using the EPA study despite the criticism by NBS of the study. Hirschorn told HMIR that OTA found virtually no documentation of how HHS arrived at its decision, and that OTA could not find out precisely what health data HHS used or whether HHS considered that low concentrations of several toxic chemicals might have a serious synergistic impact on health. OTA also found that HHS distorted to some extent the conclusions reached by the panel of 11 consultants HHS hired to review EPA's data. Hirschorn said that HHS asked the panel if "it could not be concluded that the area was not habitable." According to an assistant secretary of HHS quoted in OTA's report, the consultants concluded that "based on the data available they could not conclude that the area was not habitable."

- **EPA's remedial action at Love Canal.** OTA criticized EPA's cleanup plans for the Love Canal area on several grounds. First, OTA noted that EPA had not yet even cleaned up places in the Declaration Area known to be contaminated with dioxin. Hirschorn told HMIR that according to EPA's 1980 data, which he said is probably inaccurately low because of crude analytical techniques used at the time, dioxin was found in the Declaration Area in concentrations as high as 672 parts per billion (ppb). Hirschorn also commented that until three months ago, EPA had not even closed storm sewers which contain some of the dioxin. In addition, OTA criticized EPA's plans to build a wall around the Love Canal landfill and to cover the landfill with a clay cap as a permanent remedial measure. OTA criticized EPA and the state of New York for not planning to install an early warning leak detection system, for not planning to monitor air, soil, and biota, in addition to groundwater, for not establishing a trust fund or other permanent means to finance monitoring of the site, and for not instituting any means to pass on critical information about the site over the years. OTA also said that EPA should plan for hundreds, if not thousands of years, if it intends to make containment a permanent remedial measure.

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- **Suggestions for rehabilitation.** OTA suggested that in order to ensure habitability of the Declaration Area, EPA should do the following: 1) clean up the known dioxin sites; 2) address the problem of monitoring and maintaining the containment system; 3) provide for additional monitoring in the Declaration Area for chemicals known to be in the landfill; and 4) develop a program to deal with the permanent destruction, not just containment, of the hazardous substances in the landfill.

- **Implications for Superfund.** Hirschorn told HMIR that the Love Canal case exemplifies several problems that will continue to characterize other Superfund site actions. OTA recommended that, in order to improve the Superfund program, EPA must: 1) examine the question of how clean a site must be for it to be considered habitable; 2) establish a process for deciding when to evacuate residents near a contaminated site; 3) develop guidelines for technical monitoring at Superfund sites; 4) require that permanent disposal options, and not just containment options, be considered as options for remedial action; and 5) develop mechanisms to ensure indefinite funding of containment systems.

Richard Morris of the Love Canal Revitalization Agency (LCRA) told HMIR that he was disappointed with OTA's findings because they might retard the revitalization of the Declaration Area. Morris added, however, that he welcomes additional testing at Love Canal so that area residents know more about potential dangers there, and that he agrees with OTA that a long-term containment program needs to be closely monitored to be effective. LCRA has purchased about 12 homes in the Declaration Area in the past year and will eventually try to sell them to new home buyers.

MEDICAL AND TOXICOLOGICAL CONSIDERATION IN DETERMINING PROBABILITY OF CAUSATION OF ENVIRONMENTAL DISEASES

Bertram W. Carnow, M.D. and Shirley A. Conibear, M.D., M.P.H.

Clinical environmental and occupational medicine is at the interface of diagnostic and therapeutic medicine on the one hand and preventive medicine, including epidemiology, toxicology, and biostatistics on the other. It extends diagnosis of disease to include identification of cause. It applies the data base of epidemiology and toxicology to a single or relatively small number of cases in order to accomplish this end. In the absence of large cohorts or groups of cases, standard methods for establishing significant relationships and extrapolating probable causation do not apply. New ways of assessing the level of probability that an environmental or occupational agent and a disease are related must be utilized.

As the basis for discussion, the definition of environmental or occupational disease is one caused or significantly contributed to by one or more toxic chemical or physical agents found in the environment or in the workplace, present at a level and under circumstances which permit undue absorption and retention in the body and which result in bringing these agents into contact with cells or organs sensitive to their toxic effects. These agents then cause an altered cellular and/or organ response which adversely affects organ function and as a result, the health of the person involved.

I. Clinical Medicine: State of the Art

An assessment of the state of the art requires a description of both the clinical medicine model as it has been taught and practiced over the years and the occupational (and environmental) medicine model. Most of the clinician's training, knowledge and skills, relate to the diagnosis and treatment of disease. Until recently little or no consideration was given to seeking a cause except in infectious diseases where the organism had to be identified in order to treat the patient. More recently genetic and dietary factors and cigarettes and drugs have been causally associated with diseases of the heart, lungs, liver and other organs.

In seeking a diagnosis, the physician attempts to determine if a disease is present, the organ or organs involved, and the nature and extent of involvement. The method used follows a specific pattern which all physicians learn during medical school and residency training. This consists of data gathering, drawing a diagnostic conclusion based on choosing the most likely disease, intervening with treatment, and observing the patient to determine whether treatment is successful. Data gathering consists of questioning the patient regarding past medical history, time when first symptoms were

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recognized, patterns and severity of symptoms, and other information such as family history and lifestyle. For some diseases, i.e. chronic pulmonary, hepatic, and lung cancer, physicians frequently take a history of family disease (genetic), diet, cigarette smoking, alcohol, drugs or trauma with a view towards establishing these as significant factors in the causation of the disease. Physical examination is then performed and based on it and the history, laboratory tests are ordered. These generally consist of tests to determine levels of organ function or dysfunction except in the case of infectious diseases where blood, urine, feces, or sputum analyses may be performed in a search for causitive biological agents. Tests are generally carried out with specific organs in mind and are to a large degree oriented toward defining levels of organ function. The diagnosis of disease is based on matching these findings with a known clinical syndrome, taking into account the pattern of disease prevalence in a geographic area within a particular socioeconomic or ethnic population known to the physician through clinical experience. Treatment is then prescribed and patients followed to determine whether treatment intervention has been successful. Reassessment of diagnosis generally occurs when the treatment does not appear to have resulted in a return to a healthy state. Since the key to diagnosing a disease as environmental or occupational is the establishment of cause, where this is not done through relevant history or laboratory tests, and particularly under circumstances where physicians are not trained in toxicology, epidemiology, or biostatistics, the diagnosis is only rarely made.

This is not true for all medical disciplines. The majority of occupational diseases are dermatologic in origin, so that dermatologists have long been aware of the cause or relationship between many skin irritants and sensitizers and dermatologic diseases. Allergists, very early, came to recognize that the environment along with genetic and other factors played an important role in disease causation. The development of scratch tests, intradermal tests, and RAST were all part of the search for etiologic agents. Physicians specializing in pulmonary disease and radiology also have known about pulmonary disease from the fibrogenic dusts and have related abnormal x-rays to occupational exposures. Psychiatrists also probe for environmental causes of behavioral abnormalities, but generally these do not include the physical or chemical environment.

II. Occupational and Environmental Medicine: State of the Art

The clinical methods used to diagnose occupational and environmental diseases include the identical components described in the state of the art in clinical medicine. In addition, however, the sciences of epidemiology, toxicology and biostatistics, and the occupational and environmental data base are utilized in arriving at a clinical diagnosis and, in addition, in finding the cause.

The problems involved in establishing environmental and/or occupational factors as causative are many and provide serious challenges to the physician. These will be discussed in detail, but two types of problems should be noted. Many agents can cause similar, if not identical, diseases of a particular target organ and when present together may greatly increase the possibility that disease will result. For example, the lungs of a welder who smokes and lives in an urban environment are assaulted by metallic and other fumes at work, and cigarette smoke and air pollution at home. The result is often chronic obstructive lung disease. Additionally, some toxic agents are available from multiple sources with each source playing a role in causing disease. Carbon monoxide is one of those and is present not only in many industrial settings but also in cigarettes and automobile exhaust. Where exposure is to relatively low levels of the toxic agent over a long period of time, the symptoms and abnormal findings may present very subtlely. In such cases there is also the problem of long latency between onset of exposure and disease. Since many toxic agents affect the lungs, liver or nervous system, synergistic effects of cigarettes, alcohol and drugs increase the difficulty of establishing major environmental causative factors. The problem is also made more difficult when the cohort under study is relatively small since many of these diseases, for example cancer, usually require large members and a long period of observation to separate "background" incidence from an excess due to exposure. The differences in risk of various populations because of cultural or socioeconomic factors may also be significant and are compounded by the variability of risk in groups of individuals within a population based on many factors, which will be discussed. The occupational and environmental medicine clinician faces all of the above problems when attempting to diagnosis a disease and its' cause. There is the added problem for the clinician of carrying out this activity on a single or a few cases where no statistical assessment is possible in the classical sense.

III. Clinical Diagnosis of Environmental and Occupational Disease and Its' Cause

The diagnosis of cause is based on establishing a high level of probability that a disease syndrome is related to an exposure. This can only be done by considering a multiplicity of factors which include the availability of the hazardous agent, the probability that it has entered the body, evidence that it is present in undue amounts and whether the individual is at enhanced risk for other reasons. In carrying out this estimate of the level of probability, factors which must be considered in the history include a toxicologic and environmental exposure assessment and the individual as a biological risk. Other data obtained include laboratory tests which measure levels of undue absorption of toxic agents, tests to determine the presence of abnormalities of function of organs or organ systems, and the physical examination.

A. Toxicologic documentation

Toxicology data gathering will be considered in detail in other presentations. Discussion here is confined to examining those components obtained as part of the medical history which help to determine if undue absorption has taken place, what the excess body burden might be and its' potential for causing disease.

The ability of an agent to enter the body through one or more portals should be determined in order to assess whether undue absorption might have occurred. Some chemicals in liquid or solid form enter only through the GI tract. Others, for example dioxin, methanol and many solvents, can enter through the skin and the lungs as well as by ingestion. The percent absorbed into the body after entry is also of considerable importance. For example, lead is absorbed to the extent of five to ten percent of the total ingested in most individuals, although in young children it may be much higher. On the other hand 30 to 50% of inhaled lead may be absorbed into the body and therefore represents a much greater threat to health.

The physical characteristics of the agent are also important factors in estimating body burden, particularly when considering aerosols and particulate. In most cases it is necessary for particles to be five microns or less in size in order for them to penetrate beyond the mucociliary defense mechanism into the lower portions of the lungs where retention time and therefore absorption may be markedly enhanced. This is not necessarily true, particularly of asbestos which, because of its' great length to width ratio, acts as a small particle. Aerosolization of substances may also enhance the penetration and dissemination of a toxic agent through the lungs. The temperature, vapor pressure and the molecular weight are additional factors acting to increase or decrease absorption into the body.

The ability of the organism to degrade, detoxify and excrete a substance determines to some degree the substance's availability to various tissues and organs, and its' ability to accumulate and to cause toxic reactions in the body. Accumulation and storage of toxic agents depends to some degree on the rate of excretion. Where the major routes of excretion are known, for example, through the kidneys, quantitation of body burden may be carried out by examining the urine for the agent or its' metabolic products. This has limitations since with many substances there appears to be poor correlation of urine levels with health effects and even with true body burden.

Tissue or organ storage is another factor in determining the probability that a significant health effect will occur. In the case of a substance like lead, 90% of it is stored in the bone, where it has little effect. The important site of action in this case is not the organ of storage, but other organs including the nervous system, kidneys and blood forming organs which are the major target organs for lead. This may also be true with other chemicals. This knowledge is critical since the measurement of effect will focus on target organs.

B. Environmental and Other Exposure Factors

It is essential to consider environmental exposure factors, specifically levels of toxic agents in air, water and soil, in estimating the probability that undue absorption has taken place and that a toxic agent is present in the body at a level sufficient to produce disease. Measurements of all three may be necessary not only to determine the levels of toxic agents but the areas contaminated and in some cases the source, which may be an industrial plant or stored toxic wastes. Where an industrial plant or other point source is suspect samples must be taken up and down wind from such facilities using prevailing wind speed and direction to predict areas of high and low concentration. We found soil and dust samples to be particularly useful in determining long term deposition and therefore chronic exposure of populations in an area. Soil samples taken at 16 compass points, at variable distances from a lead smelter and at variable depths, were highly correlated with the effects on the population around the plant.

Emission and production data may be extremely useful in predicting problems. In El Paso, Texas we predicted that children with lead poisoning would be found as a result of exposure to lead emitted in high concentrations from a smelter. This prediction was based on examining emission data which were reviewed for a completely different reason. Testing revealed large numbers of children living down wind to have undue body burdens of lead with many showing evidence of lead intoxication.

Changes in production process, materials used and emission controls are additional necessary pieces of information. Another group, a community of Mohawk Indians, were exposed to an estimated 25 million pounds of fluoride dumped on their island from an aluminum smelter. Information about changes in process with subsequent reduction in emissions made it possible to provide a reasonably good estimate of the levels of fluoride available to the population. As a consequence a study is being carried out to examine the health impact of fluoride on this exposed community.

Additional environmental factors which require consideration include the general characteristics of an area such as temperature, humidity and rainfall. El Paso's warm and dry climate enhanced the amount of lead dust present on surfaces and in the air, resulting in increased exposure of children to the lead. Most of the houses had dirt floors and the roads and playgrounds were unpaved, which also increased exposure. Other environmental observations which may be useful in predicting that a problem exists includes looking for damage to fish, plants or animals in the region, rapid deterioration of metals, fabric, and paints, etching of glass, or the presence of odors. On the island exposed to fluoride, much of the vegetation had died along with virtually all of the cattle, suggesting a high level of exposure of all life on the island.

C. Biological Host Factors

In every population there is considerable variability of risk among its members even at the same dose of an agent. While many factors affecting risk differences are unknown, some are well established and need to be assessed. An important consideration in assessing the probability of a causal relationship is whether or not those expected to be at highest risk as a result of factors other than intensity of exposure, are also the ones who appear to be the first and most seriously affected.

Genetic factors in risk determination have received little consideration but may be of importance. For example, individuals with enzyme deficiencies of G6PD or sickle cell trait are more susceptible to the effects of some toxic agents on the red blood cell. Others with alpha-1-anti-trypsin deficiency, asthma or allergies might be more sensitive to toxic inhalants. Another example, the finding that those with increased aryl hydroxy hydroxylase (AHH) induceability, a genetically determined trait, are at greater risk to PAH induced lung cancer is of considerable importance. It is important that much greater research efforts should be made to find other factors which increase or decrease individual susceptibility to disease. Elaboration of additional genetic risk factors will enhance our ability to quantitate the variability of risk in population groups as has been done with cigarette smoking, cholesterol and hypertension in cardiovascular diseases.

Age must be considered since the very young and the aged, particularly those with chronic diseases, appear to be at considerably higher risk. Studies showing the causal connection between various dyes and bladder cancer also revealed that those initially exposed before the age of 25 as compared to those who began their exposure after this age, even where the duration of exposure was the same, may have been at increased risk for the development of cancer. Very young children appear to have increased sensitivity to many agents, particularly metals and solvents. In the case of lead for example they exhibit much more serious acute and chronic disease effects at lower blood lead levels than adults. The reasons for this include greater absorption from the GI tract (up to 40% of ingested lead), a poorly developed blood-brain barrier, and nutritional factors (decreased calcium or iron). The fetus is probably the most sensitive of all particularly when the toxic agent can cross the placenta - for example, lead, mercury, and lithium. Sex differences may be important where individuals are exposed to hormones, drugs, or chemical wastes or fumes which may affect reproductive organs. Additionally the physiologic stress imposed by pregnancy may be a factor in altering risk.

Those suffering from chronic diseases also represent a cohort generally at higher than normal risk when exposed to a wide variety of toxic agents depending on the organs affected and whether they are also target organs for the toxic agents. This is not only true in relation to causing further damage to organs with already reduced functional capacity but in the case of organs serving as excretory routes, such as the kidney, may result in increased body burden as a result of increased retention of a toxic agent. Chronic liver disease may lead to decreased detoxification of toxic substances, again increasing retention in the body.

Habits and cultural differences may alter the probability that an individual exposed to a toxin will develop a disease or that the disease developed is primarily related to a toxic exposure. These include cigarette smoking (possibly the most confounding variable of all), alcohol intake, nutrition, and socioeconomic status. Each may enhance the potential for developing disease due to exposure to environmental toxic agents. Where the exposure is small and the "habit factor" is great, there may be difficulty in estimating the role of the environmental factor in disease causation.

There are many other factors but only two will be mentioned. The first is a positive past medical history before exposure. The history of disease present before exposure doesn't necessarily reflect reduced impact by the toxic agent. It only suggests that health problems were present before exposure and that the person may in fact be at high risk because of lowered adaptive capacity. It does not mean that the environmental agent has not caused disease, because in fact those with previously diseased target organs generally are at enhanced risk. The second is drug intake, since these may be synergistic, or antagonistic with toxic agents or may themselves be major causative factors in disease.

D. Effects on Biological Systems

Examinations for the effects on biological systems usually follows the determination that an individual or community has been exposed to higher than normal levels of a toxic agent and that the toxic agent may have been absorbed into the body. It also usually follows measurements of undue absorption, although with some materials this is extremely difficult if not impossible, for example, asbestos. The presence of toxicants in the body in undue amounts suggests that there has been undue exposure but gives no information regarding negative health effects, only the probability that such effects may have occurred. The absence of findings of undue absorption, particularly of a toxic agent which is stored where it cannot be measured, rapidly metabolized, or excreted from the body does not even provide that kind of information, so that frequently environmental data have to be relied on to conclude that enough had entered and passed through the body to predict that undue effects on health may have occurred.

A determination of whether or not negative health effects have resulted requires taking the history of exposure or residence in an area in which toxic wastes were present, a past history of health status, and the development of symptoms. From these, and with some knowledge regarding which toxic agents were present in the individual's environment and the major target organs generally affected by this agent, relevant diagnostic procedures can be carried out. This is then followed by a physical examination and from all of these a determination made that a disease is present or not, which organ systems have been affected, and the nature and extent of the effect. These constitute a disease syndrome and, particularly where multiple organs appear to be involved, an attempt is made to relate all of them to a common or single etiologic factor. In some cases, there are unique factors or findings present which permit the determination that a "classic" environmental or occupational disease syndrome exists.

E. History

The classic clinical history obtains information about the time of onset, the progression of disease, and the duration and/or periodicity of symptoms by asking these and other questions used in standard medical practice. In addition, however, a history is taken to determine if others in the community have been affected, the relationship between the onset of symptoms and date starting residence in the community as well as information regarding environmental exposure and toxicology previously discussed. A history of past health and one which may elicit genetic abnormalities is important in assessing the risk of the individual as a biological entity.

Symptoms are critical in making a diagnosis and eliciting them is an area where most physicians possess considerable skill. Where it is suspected that a particular substance may be involved, questions can be directed toward determining whether symptoms known to be caused by such a substance were or are present. This is often the area which is not considered in general medicine. Many cases of lead colic are diagnosed as cholecystitis, ulcer or appendicitis and in some cases individuals are subjected to multiple surgical procedures before a diagnosis is made. Where symptoms suddenly surface, are not continuous or have a temporal pattern, possible changes in environmental exposures should be sought. In one situation, children who were unknowingly suffering from chronic lead poisoning suddenly developed acute symptoms. This was eventually related to the discontinued use of a baghouse with a marked increase in airborne lead in the air of the community. Under some circumstances individuals leaving a community who may have "accommodated" to an environmental stresser, that is, do not have acute disease because exposure occurs over a long time period, suddenly become ill on returning to the area. In these cases a syndrome similar to fume fever may occur. This is a disease which occurs on Monday when workers who have been away for two or more days are exposed to zinc, brass or other metal fumes. Where numbers of people are found to have onset and progression of symptoms at about the same time and where the symptoms are similar, a common etiologic factor should be suspected. This is certainly the case in infectious disease epidemics and may also be the case where environmental agents are the cause.

F. Diagnostic Test

In considering the types of diagnostic tests to be performed many factors must be considered. These include:

(a) Numbers of individuals to be tested.

This is the first and often, the most critical consideration when carrying out diagnostic testing particularly in a community where a common environmental etiologic agent is being sought. If it is felt, based on all of the considerations previously discussed, that a large number of individuals may have been exposed, or, if there appears to be a high incidence of clinical disease in the community, it may be necessary to test many hundreds of people. Where this is the case sharply reduced questionnaire length in taking histories, sophistication of tests and time that the tests take to perform, become critical considerations. Where only small numbers of individuals are being tested this does not obtain. The decision of whether to test only those who appear to have been most heavily exposed to determine whether there has been negative health impact on them as "test cases" for the community is frequently a difficult one. There may be some danger in having the rest of the community wait until initial testing on the smaller group is carried out.

(b) The location of the community.

The location of a toxic dump, contamination of a water supply or other environmental problem is frequently in a community which is physically isolated. Limitations of personnel, transportation of equipment and required storage of specimens are among many factors which must be considered in deciding which tests will be carried out.

(c) The cost of the test.

This may often be the limiting factor in studying a community particularly when the numbers to be tested are large. For example in screening for lead a zinc protoporphyrin test (ZPP) which requires only a drop of blood, costs only a few cents to do and is easily reproducible on site may be much more desirable than a blood lead which costs considerably more, or a test for ALAD which in addition to the cost must be carried out promptly. There are many other examples of ways in which cost can be reduced without sacrificing to any signficant degree the usefulness of a test. The use of a PA chest x-ray instead of including a lateral view reduces cost considerably in a first round of testing as is the use of a hematocrit or hemoglobin instead of a CBC in screening for anemia.

(d) Acceptability by the community.

There are many test that groups and communities will not accept easily, particularly those of an invasive nature, such as tissue biopsy or bone marrow aspiration. Tests which may be painful such as peripheral nerve velocity conduction, EMG, or proctoscopy will also encounter considerable resistance. Others which may cause embarrassment or carry a stigma, for example production of a sperm specimen or "psychological tests" also often encounter difficulty. In one study, people informed that a neurobehavioral battery of tests was similar to the testing of their reflexes accepted testing while mention that psychological tests would be performed resulted in mass refusal.

(e) Time needed to complete the test.

A neurobehavioral battery may require two or more hours of time to perform, trained personnel to administer the tests, and skilled professionals to score and interpret them. Where large groups are being tested this becomes almost prohibitive because of cost, personnel and time.

(f) Morbidity and mortality.

Most testing procedures carry with them a very small risk. Some, including invasive procedures or those where dye injections are required, carry an increased morbidity and in some cases even a small mortality risk. Invasive procedures, tests such as EDTA challenge and others should only be carried out after serious consideration of their need, and only by skilled and experienced professionals and where some follow-up observation is possible.

(g) Test sensitivity and specificity.

The determination of whether or not to carry out tests which may result in many false positives as compared to many false negatives is generally determined by the importance of not missing any cases in the community. During the initial screening of large communities of individuals, those tests which are more "sensitive" that is which include all positive cases in addition to some false positives are generally more desirable. During a second round of examinations after the entire community has been screened, tests specific for a disease in which only few false positives result may be more useful.

(h) Personnel and equipment.

Depending on the location of the community to be examined these may be important considerations. Equipment carried into the field must be durable, stable and portable. In urban communities where facilities and equipment are easily available and repair of equipment obtainable this is not a serious consideration. In many cases, however, toxic waste victims are in out-lying or rural areas and this becomes important. The required number of personnel and their levels of training and expertise frequently determine the cost of testing as well as the numbers of individuals that can be examined. Local individuals in communities being studied often can be trained to assist in carrying out many necessary procedures if large numbers of people are being examined.

(i) Test preparation.

Those test which require special procedures such as restricted diets or a 24 hour urine collection are often very difficult to obtain. In examining groups of workers exposed to arsenic it was necessary for them to stop eating fish or seafood which might contain this chemical for three days before the test in order that the urine might be appropriately examined. Since, in this community, fish and other seafoods are an important part of the diet this was very difficult to achieve. Fasting blood is frequently difficult to obtain in working populations particularly if they are on shift rotation, as are meat free and other types of special diets.

A wide variety of diagnostic tests are used in clinical medicine. To a large degree they examine the level of function of organ systems and when these are inappropriate or abnormal a conclusion is reached that disease of this organ may be present. Where multiple organ systems are found to be abnormal, an attempt is generally made to integrate these findings into a single disease diagnosis. Environmental and occupational medicine utilizes in addition a wide variety of tests to determine whether toxic agents are present in the body and the levels at which they are present.

The first group of tests include those which measure total body or organ concentrations. These are the most specific tests since they look for the presence of the toxic agent in order to determine its' presence and concentration in the body. They are carried out by examining the appropriate body fluids including the urine, blood, spinal fluid, saliva, sputum, hair, nails, feces, sweat or exhaled air. While these are specific in determining whether the agent is present in the body they may not provide accurate information about dose or any information about the toxic effects on body organs or tissues. Lead for example may be measured in the blood, urine, feces, hair and nails, but in fact 90% of all the lead in the body is contained in the bone where without carrying out a bone biopsy it cannot be directly measured, although x-ray findings of density in the long bones provides qualitative evidence of a heavy bone burden. While there is some evidence that blood lead provides important information regarding whether levels currently present are toxic or not, it too only indirectly provides information regarding how much is in the body and it also, fluctuates depending on when exposure took place so that levels which may have been high in the past may be normal when obtained. For this reason other body tissues have been used to assess chronic exposures such as teeth in children, which is a measure of lead during tooth development or zinc protoporphyrin which reflects the replacement of iron by zinc in the red blood cell and therefore a measure of body burden over a period of months. Hair lead provides some information regarding past body burden but has not been shown to correlate highly with toxic effects. One additional method for assessing levels in the body is a provocative chelating test where urinary lead is measured before and after a dose of EDTA. A sharp increase generally means that other tissues, particularly the bone, may contain large amounts of this metal.

A considerable amount of work has been done on the usefulness of measurements of toxic agents in various tissues in estimating body burden. Studies carried out on Minamata Bay victims, individuals who ingested large amounts of mercury from contaminated fish, found that blood and hair provided reasonable estimates of body burden. In a study of workers in multiple plants who were exposed to lead, we found that ZPP correlated reasonably well with exposure and at an FEP level of 50 micrograms per dl of blood no workers were found with blood lead levels above 40 micrograms per dl of blood. In another study, workers exposed to arsenic and with arsenic intoxication were followed with multiple examinations over a three year period. We found a highly significant correlation between exposure and hair levels of arsenic. We found no correlation with urine. Urinary arsenic appears to be a useful measure only in determining whether this chemical had been absorbed into the body over the past 72 hours. The hair on the other hand was a much more accurate reflection of the amounts absorbed by the workers in our study. While previous studies claimed that external arsenic contaminated hair specimens and made it impossible to use hair as a tissue for measurement, we did not find this to be the case. This entire area is one where a considerable amount of research effort should be expended. Studies, particularly those in which levels of toxic agents in various tissues and fluids are compared with exposure of individuals and symptoms and disease, should be carried out.

A second group of laboratory tests provides us with an indirect measure of body burden by examining urine and in some cases feces for metabolic degradation or by-products. Toluene, for example, exits through the urine as hippuric acid which can be measured. There are many other similar examples. Others which in fact are measures of interference with biochemical function also provide indirect estimates of body burden. For example, lead at almost any concentration interferes with ALAD which is essential in the production of heme and processes delta aminolevulinic acid in the body. The reduction in the enzyme ALAD interferes with this process leading to an increase in delta-ALA in the blood and urine where its levels can be measured. Levels of ALAD can also be measured although with some difficulty and have been shown to have an inverse linear relationship to lead at a level as low as 10 micrograms g/dl in the body. Another example is acetylcholinesterase which is decreased in the body in the presence of organophosphate pesticides. These latter tests, measure body burden and also the level of interference with physiologic function and therefore increased physiologic stress if not disease.

The next group of tests, those which measure the health or disease of the major organs and organ systems, are familiar to all medical practitioners and are used with great frequency in the practice of clinical medicine. These measure organ function in a variety of ways in order to determine whether they are malfunctioning and therefore are diseased.

The first group are those which measure impaired or diminished function, such as muscle strength, nerve conduction or spirometry. In these tests, muscle strength is examined to see whether it is diminished, nerve conduction to determine whether there is slowing of the impulse and spirometry to look for the inability of the lung to contain a normal volume of air or to force it out of the lungs as rapidly as it should. Another example of reduced function includes audiometry, that is, hearing ability at certain frequencies.

Another group of tests examines organ systems for increases in function. These include hyperirritability of muscle or hyperactive reflexes on the physical examination. A third group measures deviation from normal patterns. These include EEG, and ECG as well as x-rays.

One other group that should be noted are tissue tests. These include lymph node, liver, lung, muscle or other biopsies or bone marrow examinations. They may be examined for levels of toxic agents, for example, by ashing tissue, or for histopathologic changes which, while frequently nonspecific, may aid significantly in diagnosis. An example of this is beryllium which causes a granulomatous lesion similar to that of sarcoidosis, where ashing of the tissue and testing for the metal can pinpoint the diagnosis.

The problem with tests of organ function is that they are generally nonspecific since organ systems can respond only in a limited number of ways to toxic and other disease producing agents and differentiation of cause is often impossible from tests alone. It is however an important component of the "clinical syndrome" when considered together with the history and all of the other data which have previously been discussed.

G. Physical Examination

The physical examination in our experience has proven to be the least sensitive group of tests in providing information about toxic exposures. This may be because surfacing of abnormalities in such examinations generally occurs only in severe acute, or far advanced chronic, disease. Physical examination of the skin, however, may be extremely useful in some conditions. An example is chloracne, particularly in children after exposure to dioxin, PCBs and other similar chlorinated compounds. Another is keratotic skin lesions and skin burns from arsenic exposure which can be useful in making a diagnosis. Examination of the skin can also be very important where exposure to carcinogens may be suspected or has occurred. More than a million skin cancers occur each year, more than all others combined and because they are visible they are frequently detected early. They therefore represent an extremely important signal lesion of effect as well as exposure since most carcinogens are carcinogenic for more than a single organ. Neurologic examination may also sometimes reveal abnormalities where there are few or no symptoms including abnormal reflexes or movements, or muscle atrophy. In general the physical examination at best serves to confirm the history, symptoms, laboratory and other test findings.

IV. Clinical Syndrome

The large number of variables operating in the development, intensity and extent of disease syndromes makes it extremely difficult to describe a "classic" syndrome resulting from absorption of a toxic agent into the body. For example, the form of the agent can often determine the level of absorption and action in the body. Organic forms of metals such as lead or mercury may cause a disease picture very different from that occurring from an inorganic form. Also in the latter group the more soluble the form the greater the absorption so that intensity and extent of disease may vary greatly. Further, absorption of a large dose over a very short period of time may result in a remarkably different "syndrome" than lower level exposure over a very long period although the total dose may be equivalent. The body generally reacts to toxic agents as it does to any other physiologic insult. For example, an acute blood loss from 16 to 8 grams in a period of minutes or hours frequently leads to shock, renal shut-down and often death. On the other hand individuals who develop anemias over a long period can be seen ambulating with 5 or 6 grams of hemoglobin. Children living close to and downwind from a lead-zinc smelter were found with levels of blood lead exceeding 170 micrograms per dl of blood. While some of them were anemic and most revealed evidence of brain damage, they appeared to be functioning physically. Many were lethargic, had low grade gastro-intestinal complaints, were irritable, and had headaches, but much of this was ignored because these symptoms were not dramatic. In Chicago on the other hand, a child eating flaking, heavily leaded paint and developing a level of 170 micrograms almost certainly would present with encephalopathy, cerebral edema and coma.

In addition to the differences between chemical forms and acute and chronic exposures, the populations at variable risk will exhibit very different syndromes from each other. The child with acute lead poisoning will exhibit a very different set of symptoms from an adult. The chronically exposed children that we saw, on the other hand, exhibited relatively similar symptoms to the adults except that the amount of brain damage found was considerably greater. The reason for this may be that in young children more than 5%, in fact up to 30 or 40%, of the lead ingested may be absorbed into the body. Also, in very young children the blood-brain barrier is not well formed, permiting more lead to enter the brain. Additionally, the increased metabolic activity of growing children is also a factor. In both groups, however, adults and children, the ultimate target organ does appear to be the kidney.

Some "classical" clinical syndromes have been described and are almost pathognomonic in that they have very unique features. Asbestos is certainly a classic case in point. Montague Murray in 1900 was able to relate the pulmonary disease he found on examination and at autopsy of a worker to asbestos exposure. The worker he saw pointed out that others working in the same area of the plant died from lung disease and had the same symptoms he had. Massive calcification of the pleura which Murray had never seen before led him to his conclusion that asbestos inhalation caused the disease. The clinical syndrome of a history of exposure to asbestos, asbestos bodies in sputum or tissue, progressive shortness of breath, a restrictive and ultimately obstructive defect of pulmonary function, a diffusion defect, bilateral lower lobe fibrosis on x-ray with, in some cases, honeycombing of the lung, pleural plaques on the diaphragm, thickening, fibrosis, and calcification of the pleura, clubbing of the fingers and rales at the bases are all components of the syndrome, although rarely are all present in one case.

Mesothelioma and cancer of the lung and other organs may also be considered part of this syndrome, that is diseases caused by asbestos. With some other agents there are also so-called classical syndromes. Fume fever's characteristics have been noted. Other fibrogenic dusts besides asbestos such as beryllium, silica and coal produce fairly characteristic syndromes when fully developed. Even in these cases however, other diseases many be mimicked. For example berylliosis looks very much like sarcoidosis and is a systemic disease involving the same large group of organs. History of exposure, ashing of tissue and examination of it for beryllium confirms the diagnosis. Lead encephalopathy in children would be considered "classical" except that encephalitis from other causes may present a somewhat similar picture. The history of pica in a child living in an old tenement with flaking paint, exposure near a lead smelter, finding of lead in the gastro-intestinal tract, evidence of increased blood lead, anemia and other similar findings would help to differentiate this syndrome. Some toxic agents tend to have a predilection for certain systems. Metals generally affect the cytochrome oxidase system, inactivate sulfhydryl groups and interfere with cell metabolism. The effects are related to this. Many of them are also excreted through the kidney so that this organ in addition to the central and pheripheral nervous systems is generally affected. Here too, however, there may be endless variations.

Solvents are another large group which have some general characteristics although there are wide variations in clinical syndromes. They tend to enter the body through multiple routes including the skin. Because of their chemical nature they also tend to defat the skin, affect the liver and as a group generally tend to have narcotic properties and affect the central and peripheral nervous systems. They can affect other organ systems as well, but particularly the liver so that a "classical" clinical syndrome for toluene might include a cracking of the skin, central nervous system depression, fatigue and dizziness and possibly liver enzyme changes.

A heightened level of consciousness of the possibility that environmental factors might be closely related to disease is critical to considering the "disease syndrome". During an evaluation and examination of a group of workers heavily exposed to chlorinated hydrocarbons medical records of evaluation and treatment by physicians who saw them during the first year following exposure were reviewed. Some had been diagnosed as having skin problems by a dermatologist, bladder problems by a urologist, hepatic disease by an internist and acute depression and anxiety by a psychiatrist. There was no intergration of these organ diseases into what was clearly a clinical syndrome resulting from exposure to a toxic agent.

It would seem appropriate to end this presentation with some recommendations in addition to those already made, for future activities in environmental medicine. The first is to qualitatively increase the didactic and clinical offerings in occupational and environmental medicine to medical students and residents in medicine. Continuing education programs for physicians should certainly contain lectures and other educational offerings dealing with the impact of environment on health, with suggestions about expanding the clinical history in office practice to include the work and community environment. This is particularly relevant for those who completed their medical education before it became generally recognized that environmental exposures were often causally related to clinical disease.

Finally a significant effort should be made to formally train physicians as specialists in environmental medicine. Since occupational medicine is a microcosm of environmental medicine it represents a discipline where such training is already being carried out. Until the development of the NIOSH educational resource centers, less than 700 certified physicians were practicing occupational medicine as a speciality and of those less than 200 received formal training in this specialty. Physicians trained in occupational medicine are required to develop skills in environmental health, biostatistics, epidemiology, and toxicology and to have some knowledge of industrial hygiene and industrial process. Physicians seeing individuals with diseases that could or might be environmentally related will attempt to answer questions such as:

1. Is the temporal relationship of exposure to developing pathology reasonable and logical?

2. Was the dose of the toxic material sufficient to cause the pathology?

3. Are measures of body burden in the range where disease is known to occur?

4. Is the pathology of the nature of what would be expected of this material?

5. Have other diseases that might cause the same pathology been ruled out?

6. Are those in the population expected to be at higher risk the ones who develop the disease?

7. Are others similarly exposed, similarly affected?

In a paper appearing in January 1971 (Arch. of Internal Medicine, Volume 127) on air pollution and physician responsibility, Carnow stated:

1. The physician should become knowledgeable regarding the relationship of environmental factors to disease.

2. The physician should search for clues to the environmental-disease relationship in the clinical patterns of disease so that definitive epidemiological studies can be carried out as extensions of these clinical findings.

3. The physician should support and participate in studies searching for the complex physical, biological and psychosocial etiologic factors in the changing patterns of disease morbidity and mortality by coupling medical insights with computer technology.

4. The physician should intensify research into the nature of man's interaction with his ecologic system as it relates to health and disease and lend support to the training of physicians who will become environmental specialists and develop this new discipline. These experts can then with engineers, biologists, ecologists, and others of like disciplines assess the health consequences of social and environmental changes and based on a cost benefit analysis (the cost to health as compared to the benefits and comforts given to man determine the value to man of these changes).

5. The physician should develop a therapeutic approach which will consider and utilize environmental etiologic factors. The evidence presented suggests that some high risk groups are already known and have been isolated. These are particularly the very young, the

poor, and the older age groups with chronic heart and lung disease and those with asthma. Thus evaluation of a chronic bronchitic or cardiac patient should consider the risk factors including disease severity, pollution hypersensitivity, and the general degree of environmental degradation. This would enable the physician to classify the patient as to degree of pollution risk and to use this as a guide for regulating activity and medical dosage in relation to pollution levels. Individuals found to be environmental hyperreactors might even be advised to leave communities where pollution frequently achieves high levels.

Finally, we cannot procrastinate with pollution as we did with cigarettes, where our timidity has cost many thousands of lives. Physicians must become involved and begin to deal with the extremely complex problem of assessing the degree of environmental deterioration which has occurred along with its impact on health. We must begin to grapple with ways to structure a viable environment for future generations. We must see to it that our organizations are intimately involved in a positive way with these and other major problems of our times. Members of the medical profession must give time and energy to serve on legislative and advisory councils, committees, and boards in order to assure that human health will be a major consideration in the deliberation of engineers and legislators in defining legislative needs. Never before has society presented the physician with so wide a field of activity and with so much opportunity to play a key role. This is the time for the physician to become the asklepios politkos visualized by Plato.

Given the enormous toxic waste problems we now face and the increased community awareness and concern regarding the impact of environmental contaminants on health this course of action is even more relevant today than it was a decade ago.

DETERMINATION OF CAUSATION IN COMPENSATION OF PERSONS CHRONICALLY INJURED BY TOXIC SUBSTANCE EXPOSURES

SUMMARY

Contrary to an often-expressed critique of the tort law system, proof of causation in chronic injury/chemical exposure cases is not an impossible task. To the contrary, scientific knowledge can be employed to determine whether any plaintiff's exposures were substantial enough to justify a finding that chemical exposure caused his injury. The basic criterion, consistent with both science and law, should be whether or not plaintiff's exposures were severe enough to double the likelihood that he would contract the disease. Such a criterion can be reasonably adjudicated in the courtroom and is fair both to plaintiffs and to defendants to whom responsibility could be allocated for compensation.

Although causation issues can fairly be adjudicated in the courts, merit may exist in allowing some types of chronic injury compensation cases to be adjudicated through an administrative system. If such administrative schemes are established, they should, however, retain the "doubling" causation requirement as the appropriate criterion for granting awards. Many currently proposed schemes fall short of incorporating such an equitable causation requirement.

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I. INTRODUCTION.

It is almost impossible to discuss compensation of persons alleging chronic injury due to toxic substance exposures without first confronting the causation issue. Whether compensation is to be provided through the traditional common law tort litigation system, through workers' compensation programs, or through oft-proposed new administrative schemes, an underlying issue is always what evidence shall be relied upon, in what manner, to determine whether any claimant is suffering from a disease caused by exposure to toxic substances.

Appropriate determination of causation of chronic diseases by toxic substance exposures requires application of scientific findings and principles. Until recently, the law typically did not have to depend on scientific expertise in individual injury cases to make causation judgments. If a person were injured by a malfunctioning piece of equipment, or by an acute chemical exposure, little question existed as to the agent causing injury -- although great debate may have occurred as to responsibility for the damaging occurrence. With the emerging recognition that chronic diseases could be caused by many factors including long-term chemical exposures, and that such diseases typically are not manifested until many years after exposure, more difficult questions of causation have emerged and the necessity of employing scientific assistance has become apparent.

The need for increased scientific assistance in making causation determinations has led many commentators to conclude that the traditional common law tort system is ill-equipped to handle personal injury toxic substance compensation claims. "Determining causation is the central uncertainty in establishing liability for harm caused by toxic substances," writes the author of the Environmental Law Institute's recent call for an administrative compensation scheme.1/ The Superfund Section 301(e) Report's call for a similar administrative scheme is premised on the same conclusion: "Proof of causation is one of the major obstacles faced by a plaintiff in a court action for exposure to hazardous waste."2/ Given the premises of each of these reports that substantial numbers

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1/ J. Trauberman, Statutory Reform of "Toxic Torts:" Relieving Legal, Scientific, and Economic Burdens on the Chemical Victim 7 (Environmental Law Institute, September 1982) [hereinafter ELI Toxic Torts Study].

An earlier ELI study had reached the same conclusion: "[P]laintiffs in toxic pollution suits may have substantial difficulty in proving that a particular exposure to a pollutant was a cause if fact of an injury." Environmental Law Institute, Six Case Studies of Compensation for Toxic Substance Pollution: Alabama, California, Michigan, Missouri, New Jersey, and Texas, 517 (Senate Comm. on Environ. and Public Works Comm. Print, 96th Cong., 2d Sess., Serial No. 96-13, June 1980) [hereinafter Six Case Studies].

2/ Injuries and Damages from Hazardous Wastes -- Analysis and Improvement of Legal Remedies, A Report to Congress in Compliance with Section 301(e) of the Comprehenesive Environmental Response, Compensation and Liability Act of 1980 (P.L. 96-510) by the "Superfund Section 301(e) Study Group," Part 1, The Report and Comments, at 194 (Senate Comm. on Environ. and Public Works, Comm. Print, 97th Cong. 2d Sess., Serial No. 97-12, Sept. 1982) [hereinafter 301(e) Report]. This Report is extensively discussed in § 4B, infra.

of persons are suffering chronic diseases due to toxic substance exposures[3] (a premise that is highly speculative at best[4]), the alleged difficulties of causation determination

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[3] See, e.g., ELI Toxic Torts Study, supra note 1, at 1-2; 301(e) Report, supra note 2, at 6-18; Six Case Studies, supra note 1, at 514-21.

[4] Although it is not the purpose of this article to explore whether or not such an epidemic of disease exists, repeated reliance on such claims as the basis to argue for new compensation proposals requires that such claims not go unaddressed.

Often cited, for example, is the 1980 conclusion of the U.S. Surgeon General, that "[w]hile it is impossible to determine the magnitude of the toxic chemical risk, it is clear that it is a major and growing public health problem ... ." Health Effects of Toxic Pollution 1 (Senate Comm. on Environ. and Public Works, Comm. Print, 96th Cong., 2d Sess. Serial No. 96-15, August 1980), as cited, e.g., in ELI Toxic Torts Study, supra note 1, at 1; Section 301(e) Report, supra note 2, at 9 n.18. Despite the conclusory statement, this lengthy report of Government cancer research efforts contains no empirical data in any way assessing the magnitude of disease caused by chemical exposures.

One of the few areas where epidemic claims have been assessed involves the claim that more than 20% of all cancer deaths in the United States can be attributed to occupational chemical exposures. National Cancer Institute (NCI), National Institute of Environmental Health Sciences (NIEHS), "Estimates of the Fraction of Cancer Incidence in the United States Attributable to Occupational Factors" (1978).

Because these NCI/NIEHS claims were given so much prominence by then-HEW Secretary Joseph Califano, many distinguished scientists found it necessary to respond. The claim was quickly perceived as "scientific nonsense" by many (see, e.g., Editorial, "What Proportion of Cancers Are Related to Occupation?," Lancet (Dec. 9, 1978); Abelson, P.H., "Cancer -- Opportunism and Opportunity," 206 Science 11 (Oct. 5, 1979)), and finally and definitively put to rest in an exhaustive study by the distinguished Oxford University scientists Richard Peto and Sir Richard Doll. In a lengthy report commissioned by the U.S. Congress' Office of Technology Assessment, Doll and Peto concluded:

> Examination of the trends in American mortality from cancer over the last decade provides no reason

(Footnote 4 continued on next page.)

lead to proposals not only for administrative compensation schemes, but also for relaxed causation standards to enhance the likelihood of what is assumed to be warranted but presently unobtainable compensation.[5]

Although not often detailed in the legal and scientific literature, an equally strong perception exists among defendants that the tort system all too often makes affirmative causation determinations on the slimmest of evidence, thus often rewarding persons not truly deserving of compensation.

(Footnote 4 continued from previous page.)

> to suppose that any major new hazards were introduced in the preceding decades, other than the well-recognized hazard of cigarette smoking, which has extended from men to women, and the cause (whatever it may be) of the increase in melanoma.

R. Doll and R. Peto, "The Causes of Cancer: Avoidable Quantitative Estimates of Avoidable Risks of Cancer in the United States Today," 66 J. NCI 1191, 1256 (1981). Indeed, their exhaustive study of all "environmental" agents associated with cancer demonstrated only a small percentage of cancer deaths are attributable to the types of exposure contemplated for administative compensation schemes; their best estimates of percent of cancer deaths attributable to various causes were headed by diet (35%), tobacco (30%), infection (10%), and reproductive and sexual behavior (7%). Of much lesser significance were food additives (<1%), pollution (2%), occupation (4%) and industrial products (<1%).

[5] Reduced or relaxed causation burdens have been proposed, and almost uniformly claimed to be justified by the difficulty of proving causation, inter alia, by the 301(e) Report, supra note 2, at 202-205; Soble, S.M., "A Proposal For the Administrative Compensation of Victims of Toxic Substances Pollution: A Model Act," 14 Harv. J. Legis. 683, 796-800 (1977); Rea, R.A., "Hazardous Waste Pollution: The Need for a Different Statutory Approach," 12 Environ. L. 443, 450, 467 (1982); Ginsburg W.R., and Weiss, L., "Common Law Liability for Toxic Torts: A Phantom Remedy," 9 Hofstra L. Rev. 859, 938-39 (1981); and, Note, "Compensating Victims of Occupational Disease; 93 Harv. L. Rev. 916, 931 (1980).

Such fears are well-grounded in actual experience by precedents such as the $58 million awarded to 47 workers at a chemical spill clean-up in Sturgeon, Missouri, where little more than speculation existed to demonstrate workers would develop disease.[6] Similarly, physicians who have reviewed the evidence in many of the thousands of asbestos lawsuits have noted that less than half of the plaintiffs in fact have diseases that scientifically can, or should, be associated with asbestos exposures.[7] Similarly, the vast array of ills now alleged to have been caused by Agent

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[6] Washington Post, Sept. 10, 1982, at A8.

[7] See the comments of Dr. Hans Weill of the Tulane University School of Medicine that science would be unable to prove that more than 50 percent of the plaintiffs now suing asbestos manufacturers and the Government had diseases related to asbestos exposures. "Occupational Health and Safety Letter," Sept. 22, 1982, at 6; "BNA Occupational Safety and Health Reporter," Sept. 23, 1982, at 339.

Many asbestos claims involve allegations of asbestosis, a chronic lung condition. Because of the unique radiologic signs of asbestosis, trained X-ray readers, such as Dr. Weill, are able to distinguish it from lung conditions caused by other agents, including dusts, such as silica, and smoking. Having reviewed X-rays of many hundreds of plaintiffs, Dr. Weill reported that the majority of plaintiffs should not be found to have asbestos-related lung disease.

See also the letter from C. F. Fuhrman, M.D., to the Wall St. Journal, Sept. 22, 1982, at 31, noting:

> I am frequently asked to see individuals with asbestos exposure. ... I recently saw one man who was told by his lawyer that he was going to get him "big money" because of his asbestos exposure. A careful review of this man's medical history indicated that he had, indeed, worked with asbestos in the past, but at the present time he did not have either mesothelioma, a cancer specifically related to asbestos exposure, or asbestosis, a medical condition that results from asbestos exposure.

Orange in Vietnam, although not yet adjudged by the courts, scientists, or the Veterans Administration to be legitimate,[8] create concern that causation could all too often and all too easily be found by sympathetic judges and juries.

A vast perception gap thus exists in assessing the likelihood that causation will be able to be proven in cases brought by persons alleging chronic injury due to toxic substance exposures. In order to provide a reasoned framework to explore this gap, we first review what science has to teach the lawyer about causation in chronic disease cases before further considering how well the common law torts system has, and can, deal with such issues. This latter assessment then provides the necessary context within which we review alleged inadequacies of the current compensation system and critique various proposed administrative systems.

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III. USE OF QUANTITATIVE SCIENTIFIC DATA IN LAWSUITS.

Although the conceptual framework for determining causation in chronic injury lawsuits seems simple enough, it should be adjudged against practical experience. This section therefore discusses the experience of courts to date with the types of statistical presentations that would be necessary to use scientific data and the likelihood judges and juries would profit from such presentations. Finally, we assess (and find wanting) the variety of arguments that have often been made by persons who conclude the legal system is ill-equipped to make such causation determinations.

A. The Experience of Courts in the Past.

Despite the apparent relevance of quantitative data to chronic hazard lawsuits, its use has been sparse. Reported opinions discussing such data are admittedly difficult to find.[39] Several explanations no doubt account for the paucity of precedent.

First, the development of sufficient scientific data to make quantitative presentations on many substances is relatively recent, and the filing of chronic hazard actions where it would be relevant is also of relatively recent vintage.[40] In addition, many cases may have been tried by juries, and not appealed, thus precluding the need for a reported decision on the merits. Even when appealed, many cases may have been decided on issues other than the factual merits.[41]

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[39] *See* Stason, *et al.*, *supra* note 11, at 456, concluding:

> It might have been expected, therefore, that there would be a considerable body of legal literature analyzing the probative value of such [scientific] material to prove causation and extent of injury, or at least that there would be a considerable number of cases illustrating the use of such material. Yet a search of the digests, annotations and periodical indexes proves singularly unrewarding, and a reading of those cases in which statistical evidence surely should have been used does not prove to be much more helpful.

Although Stason reached this conclusion more than twenty years ago, the absence, in reported opinions, of discussion of well-presented quantitative data remains true today.

Second, in many of the most frequently litigated chronic injury lawsuits to date, causation has often not been in doubt or the peculiar symptoms of disease rather than probabilistic evidence were the determinant factors. In many bar such data in the future.[44/] An expert testifying on causation can typically be cross-examined on all the data on which he bases his conclusions, even if he did not do the studies himself. Common sense argues for having the expert explain the basis of his conclusions rather than merely attributing them to his expert knowledge (which obviously must come in part from familiarity with such studies).

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[40] A recent complaint filed in Massachusetts alleging groundwater contamination caused a number of leukemias in the area of several industrial facilities demonstrates the likelihood such quantitative presentations will be made more frequently in the near future. The complaint sets forth for each chemical alleged to have been released into the groundwater its potency (derived primarily from animal experiments), the level of the chemicals in the water, and plaintiffs' conclusions that the risks of developing cancer were thus much increased. Anne Anderson, *et al.*, v. Cryovac, Inc., *et al.*, (Mass. Superior Ct.), filed May 19, 1982, reprinted in Frost, E.B., and Rogers, J.A., Co-Chairmen, *Toxic Materials* 414-44 (Harcourt Brace 1982). Similar quantitative facts are typically alleged in Government Superfund complaints. See, *e.g.*, United States v. Chem-Dyne Corp. (S.D. Ohio), filed 1982, reprinted, *id*. at 236-68.

[41] In addition, given the general tendency of reviewing appellate courts not to disturb trial court factual findings, detailed review of the facts presented at trial may often be lacking in appellate opinions. A good example in a chronic injury case is Garner v. Hecla Mining Co., 431 P.2d 794, 19 Utah 2d 367 (1967), which affirmed denial of a worker's compensation claim for cancer alleged to be due to radon gas exposure. The court noted it had "no doubt about the propriety of receiving and considering ... scientific data and expert opinions based thereon concerning the high incidence of lung cancer in uranium miners, because they are relevant to the critical problem [causation] here." However, the court was precluded from reversing the compensation board by its strict standard of review, namely to review the evidence "in the light most favorable" to the board's conclusion and to reverse it only if "there is credible evidence without substantial contradiction which points so clearly and persuasively in plaintiff's favor that failure to so find [in his favor] must be regarded as capricious and arbitrary." *Id*. at 796.

Fourth, there is no doubt a perception among many trial lawyers that statistics will make a case too difficult to comprehend. Alternatively, lawyers may fear that the old aphorism -- statistics often lie -- will cause the triers of fact not to credit such presentations. Whether or not such perceptions are valid,[45/] they may have led many litigating lawyers to rely solely on qualitative expert opinion.

44/ Precedents exist on both sides of the issue of whether scientific studies can be introduced into evidence despite the hearsay rule. See Harley, R.G., "Proof of Causation in Environmental Litigation," in Toxic Torts 403, 408-410 (ABA 1977); Stason, et al., supra note 11, at 450-53. As noted in Green, supra note 43, to the extent expert conclusions are based on knowledge and interpretation of the relevant scientific literature, including epidemiology or animal studies, the evidence from such studies will, and should, at least indirectly, be presented to judge and jury.

A number of epidemiology studies were admitted at the first Rely-Tampon toxic shock syndrome trial. See National Law Journal, March 29, 1982, at 6.

45/ The merits of such fears are discussed at pp. 36-40, infra.

Although statistical evidence has rarely been employed in reported chronic hazard litigation,[46] it is useful to review a case where such statistics were crucial to the court's evaluation of causation. In Mahoney v. United States[47] three plaintiffs blamed their respective Hodgkin's disease, acute granulocytic leukemia, and lymphatic leukemia, on their respective 2.2, 2.6 and 4.06, rems cumulative radiation exposures. In a judge-tried case, the court held causation had not been proven based on evidence showing, inter alia, the leukemia rate in the plant was one-third the national and state average rates; these cancers had not been found among Hiroshima and Nagasaki victims exposed to much higher levels of radiation; natural background and X-ray diagnostic average exposures to radiation were of the same order of magnitude as these worker exposures; and a linear extrapolation of the radiation risks found at higher dosages predicted only a 1 in 24 chance that the diseases would have been caused by the doses the men experienced.[48/]

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[46] The absence of scientific data in some early tort suits involving cancer led to unsound results. Plaintiffs often prevailed in attributing cancer to traumatic falls with evidence that they were in fine health before the falls but were stricken with cancer subsequently, buttressed solely by an expert's opinion that traumatic shocks are one of the possible causes of cancer. As one legal commentator has written of these unscientific judicial findings:

> Thus does the law rush in where science fears to tread, "proving" cause-in-fact with one theory of causation out of many (and that theory of questionable virtue), allowing a minimum of circumstantial evidence to indicate a circumstantial theory of causation, and saying, that in the absence of affirmative proof to the contrary, the impact and the injury, plus a few facts, such as prior good health, speak for themselves on the issue of causation if the jury wants to accept them.

Stason, et al., supra note 11, at 427.

The cancer/trauma cases are extensively reviewed in Columbia Note, supra note 20, at 349-54. As that review concludes, although scientifically indefensible, such precedents demonstrate "the tendency of courts, faced with a disease which neither they nor the medical profession understands, to follow the evidence of their senses." Id. at 354.

[47] 220 F. Supp. 823 (E.D. Tenn. 1963), aff'd per curiam, 339 F.2d 605 (6th Cir. 1964).

Mahoney serves as a prime example of how properly presented epidemiologic evidence, when combined with solid information on worker exposures, can provide meaningful guidance to a court grappling with chronic hazard causation. The court had no particularly insurmountable difficulty in assessing quantitative scientific data (even though the expert witnesses differed in its interpretation), nor in relating the teachings of such data to the legal issue of causation. Rather, presentation of such data made it possible for the court to judge appropriately and reasonably the merits of plaintiffs' claims to have suffered disease due to occupational exposures.

[48/] Id. at 835-36, 839.

These data conflicted with plaintiffs' claim that the probability that their cancers were due to plant exposures was 10,000 to 1 in their favor, a claim based on an assessment of the leukemia and Hodgkin's disease rates in the plant. The court, however, found plaintiffs' data flawed because their expert had incorrectly assumed the plant had 800 workers, when in fact it had had more than 31,000. Id. at 840.

The value of quantitative presentations in worker's compensation cases involving chronic diseases is also clear. As one review of such cases emphasizes,[49/] courts have often had to review cases where experts, without employing quantitative data, merely testified to a "possibility" that disease was due to occupational exposure. Not surprisingly, in light of accepted legal causation doctrines, such "possibility" was typically found insufficient. On the other hand, in cases where experts asserted the underlying scientific data made causation "probable,"[50/] courts were able to

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49/ Columbia Note, supra note 20, at 355-58.

50/ See, e.g., McCallister v. Workmen's Compensation Appeals Board, 69 Cal. 2d 408, 71 Cal. Rptr. 697, 445 P.2d 313, 316 (1968).

Some courts, have, however, clung to the formal scientific causation requirement of mechanistic proof going beyond compelling statistical probability. For example, Miller v. National Cabinet Co., 8 N.Y.2d 277, 168 N.E. 2d 811, 204 N.Y.S.2d 129 (1960), affirmed denial of a claim for leukemia attributed to benzene exposures in the face of evidence that "the incidence of leukemia is 'quite high' in patients who have been exposed" to benzene.

It might be possible to attribute the Miller court's unwillingness to rely on statistical probabilities to the failure of the expert witnesses to make a compelling statistical presentation were it not for its comment approving a decision in another case where compelling statistical data apparently was presented but not followed:

> Would, for example, evidence that there are 4 to 11 times as many cases of lung cancer among cigarette smokers as among non-smokers ... be sufficient to establish a cause of action for breach of warranty in the sale of cigarettes? The United States District Court in Pittsburgh has apparently held not ... . There appear to be no decisions upholding causation in so complex a variety of the disease as leukemia.

Id. at 815.

find more probably than not that exposures substantially contributed to disease. In either case, the failure of experts to put their conclusions into a quantitative framework often left courts struggling with ephemeral differences between "possibly" and "probably" that may well have reflected innocent choices of words much more than true differences in the evidence. By employing a quantitative framework, it should be expected that courts would be better able to assess causation evidence. Before reaching that conclusion definitively, it is useful to review sometimes advanced arguments that statistics will do more harm than good in helping judges and juries make valid decisions.

B. Speculation About How Judges and Juries May Interpret Quantitative Data in the Future.

Use of quantitative scientific data has been urged by lawyers oriented toward both plaintiffs and defendants.[51] Such bipartisan support argues for the neutrality of such evidence, but the paucity of use in the past makes it difficult to predict its consequences. It is therefore useful to review theoretical arguments against use of statistics that have appeared in the legal literature.

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[51] *See* Shelton, *supra* note 11; Rheingold, P.D. and N. Jacobson, "The Toxic Tort Cause of Action: Law and Procedure," in *Toxic Torts* 1, 33 (ABA 1977).

Resistance to use of quantitative data in lawsuits stems primarily from the argument that manipulation of numbers will be overly persuasive to judge and jury. It has, for example, been argued that the seeming preciseness of statistical presentations may unduly influence a jury to decide in accord with the statistics.[52] One can, however,

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[52] The argument that the undue persuasiveness of statistics should generally make them inadmissible in trials is most vehemently argued by Tribe, L. H., "Trial by Mathematics: Precision and Ritual in the Legal Process," 84 Harv. L. Rev. 1329 (1971). Professor Tribe's article is one of the best known of a plethora of scholarly discussions over the past fifteen years on use of statistics in lawsuits. See Kaye, D., "The Laws of Probability and the Law of the Land," 47 U. Chi. L. Rev. 34 (1979), and articles cited therein at 34, notes 1-6. Much of the debate concerns a more expansive use of statistics than is advocated here, and thus many of the arguments are irrelevant to consideration of the value of quantitative data in chronic hazard cases. Nonetheless, Tribe argues against use of statistics in one hypothetical that is quite similar to the chronic hazard setting.

Tribe hypothesizes that plaintiff is negligently run down by a blue bus and that four-fifths of the blue buses in town are owned by defendant and then asks (supra at 1341): "What effect, if any, should such proof be given?" He concludes that the question of the admissibility of such statistical evidence is "a very close one" because of the overly persuasive nature of the statistical presentation (id. at 1361, n.102). Tribe's argument against admissibility is premised on the conclusion that such evidence alone should not be sufficient to carry the day. He argues that one would expect other evidence to be available to identify the owner of the bus and thus (id. at 1349):

> [U]nless there is a satisfactory explanation for the plaintiff's singular failure to do more than present this sort of general statistical evidence, we might well rationally arrive, once the trial is over, at a subjective probability of less than .5 that defendant's bus was really involved in the specific case.

Critics of Tribe have made it clear they find the blue bus hypothetical not all that difficult and that they have no difficulty with admission of such statistical evidence. As Kaye, supra at 40, notes:

(Footnote 52 continued on next page.)

perhaps just as persuasively argue that jurors will turn statistics against the party relying on them. It is possible, for example, that use of statistics will emphasize to jurors the often not insignificant possibility that their decisions will be wrong, thus leading them to rely more on subjective factors to decide a case in favor of the party on the short end of the statistical stick.

For example, assume a worker suffering from cancer sues a large company to whose chemical products he was exposed and that epidemiologic evidence shows a 20% probability the cancer was caused by the chemicals. Will the judge refuse (as the "more probably than not" standard provides) to allow this case to go to the jury? Will the jury determine (properly) that a 20% chance is in fact less than more probable than not? Or, will both judge and jury feel uncomfortable denying causation, and thus refusing damages, in cases where a 50% probability standard is not met, but where it is nonetheless clear that there is a not insignificant one-in-five chance that causation exists.

(Footnote 52 continued from previous page.)

> A rule of law denying the plaintiff recovery in such a case could not establish that probabilistic reasoning is inapplicable or that jurors would not be well advised to find facts according to their best estimates of the relevant probabilities. It would merely reflect the policy that where individualized evidence is likely to be available -- evidence which would typically permit better estimates of the probabilities than can be had from the background statistics alone -- plaintiffs should be forced to produce it.

In cases without a quantitative presentation, the inability to relate causation issues specifically to numbers will often obscure the ability to see so clearly the probability of a wrong decision. With numbers, the reality of what is being determined will be clearer; and, as one commentator has noted, triers of fact may be disturbed by the explicit understanding that there remains some probability their decision will be wrong:[53/]

> To make the case turn on whether the percentage is forty-nine or fifty-one, illustrates the unfairness, in an individual case, of our system of awarding damages on the basis of probability.

Rarely, of course, will the quantitative data be so clear. Although defendant's expert may calculate only a 20% probability of causation, plaintiff's expert may say he

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[53/] Stason, et al., supra note 11, at 500.

As has been recognized about the "beyond a reasonable doubt" standard in criminal cases, were it expressed in probabilistic terms, juries might be more reluctant to convict:

> Surely it is not some defect in probability theory that restrains us from instructing jurors that they should convict so long as they are, say, at least ninety-five percent certain that the defendant is guilty. A much simpler explanation is that we would prefer not to advertise the fact that we are willing to sacrifice one innocent person in order to secure the conviction of nineteen guilty ones. Some things, it has been argued, are best left unsaid.

Kaye, supra note 52, at 40 (footnote omitted). Similarly, juries may be reluctant to absolve large company defendants when the probability of being wrong, although less than 50%, is nonetheless significant.

interprets the same, or other, studies to show a 60% probability. In such a case, the jury would have to decide which quantitative expert to believe, just as juries now evaluate conflicting qualitative expert testimony. Whether or not expert reliance on statistics to back up opinions will change the outcome in any given case is difficult to predict. Regardless, it is not appropriate to assume a priori that admission into evidence of statistics and quantitative scientific data would be unfair to either plaintiffs or defendants. Rather, the data itself should be viewed as a neutral aid to decisionmaking. Such data inevitably will gain or lose persuasiveness based on both its intrinsic merits (i.e., the soundness of the studies and assumptions upon which any assessment of human risk is based) and the ability of opposing parties to present that data in a manner comprehensible to judge and jury.54/

C. Assessment of Arguments That the Torts System Cannot Handle Chronic Injury Causation Issues.

It cannot be gainsaid that determination of causation in a chronic injury/toxic substance case is not a simple

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54/ Some may argue that requiring scientific evidence to support a claim of chronic injury causation establishes an unreasonably high barrier to plaintiff recovery because of the absence to date of extensive studies (either in animals or man) of many chemicals. The absence of such data for many chemicals cannot be doubted, but the alternative -- finding cancer causation on the basis of surmise and speculation -- can hardly be considered a fair approach to allocation of responsibility for injury.

exercise. Nonetheless, the arguments often made that such difficulties mandate shifting toxic tort compensation to an administrative scheme do not flow naturally from any reasoned understanding of such difficulties. In light of the scientific and legal causation discussion above, it is valuable to review the arguments commonly made about the inability of the torts system to assess causation in chemical exposure/chronic injury cases to determine what, if any, merit those arguments have and thus whether such lawsuits must be shifted to an administrative compensation scheme.

First, the persistent claim that numerous precedents already demonstrate the torts system cannot cope with chronic injury claims, in fact, is little more than an article of faith among those who have proposed providing compensation through administrative schemes. Several lengthy Government reports often are cited for the proposition that personal injuries are not compensated by the torts system, but these studies offer no empirical demonstration of any such inability. For example, although often relied upon as the primary evidentiary basis for assertions that compensation remedies now available are inadequate, the Environmental Law Institute's Six Case Studies in fact has little, if any, data to support such assertions. Of the six case studies -- which were chosen specifically because they were believed to demonstrate "substantiality of harm"55/ -- only two include

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55/ Six Case Studies, supra note 2, at 13.

any evidence of personal injuries due to chemical exposures, and injured persons received compensation in each.[56]

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[56] The first study, "Alabama," involved PCBs found in a river and lake due to transformer manufacture beginning in 1951. Although the report repeats the typical litany of chronic effects known to be caused by significant PCB exposures in animals, it includes not a single piece of data indicating any humans suffered any such effects from the PCBs here. Id. at 15, 71-74.

Similarly, the Report acknowledges neither acute nor latent medical effects have resulted from the radiation and DBCP groundwater contamination and that no personal injury suits have been filed in the second "California" case study. Id. at 20, 148-52, 168. Only headaches and nausea are claimed to be implicated in the groundwater contamination from the third "Michigan" waste disposal study. Id. at 29, 224-26. The pattern of absence of documented medical effects is the same in the "New Jersey" waste site groundwater contamination case. Id. at 39, 354-56.

The only two case studies to include allegations of actual personal injury have both resulted in sizeable settlements with claiming plaintiffs. In the "Missouri," dioxin horse stable incident, acute injuries were alleged for seven persons, and the two girls alleging greatest exposure had either received settlements or still had suits pending. Id. at 288-94. And, in the "Texas" lead smelter cases, plaintiffs who have alleged one death from acute lead poisoning, three mental retardation cases, and 35 hospital treatment cases, had achieved settlements of more than $0.5 million and other cases were still pending. Id. at 51-52, 413-17, 428-34.

The same general pattern of either absence of even alleged harm, or presence of sizeable awards when real harm was alleged, exists in the six other case studies summarized, but not discussed in detail, in Six Case Studies. Id. at 17, 26, 31, 43, 47, 55-56.

Despite its clear failure to demonstrate that the tort system cannot adequately and fairly allocate responsibility for chronic injury personal compensation, Six Case Studies, and the predecessor Congressional Research Service report, "Compensation on Victims of Water Pollution," (House Comm. on Public Works and Trans., Comm. Print, 96th Cong. 1st Sess. Serial No. 96-4, May 1979), which included some of the same case studies, have been cited time and again as the linchpin demonstration of the system's inadequacies. See, e.g., Rea, supra note 5, at 447 n.22, 448 n.27; Note, "Hazardous Waste Liability and Compensation: Old Solutions, New Solutions, No Solutions," 14 Conn. L. Rev. 307, 322 n.81 (1982); ELI Toxic Tort Study, supra note 1, at 7, n.9.

Similar to the claim that the torts system cannot cope with chronic injury causation is the argument that workers' compensation fails to cope adequately with occupational disease. The Department of Labor, for example, reported to Congress in 1980 that it believed, "[o]nly five percent of those severely disabled from an occupational disease receive workers compensation benefits . . . due in part to the difficulties involved in establishing the work-relatedness of disabling illnesses."57/ A more recent survey, also done for the Department of Labor, casts doubt on that conclusion.58/

Professor Peter Barth sought information on the workmen's compensation experience in the nationwide cohort of all insulators who Dr. Irving Selikoff had concluded died of asbestos-related disease. Of the claims filed and decided, almost all were granted. Only 9 of 136 disability claims, and fewer than 2% of death claims, were denied.59/ An

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57/ U.S. Dep't of Labor, "An Interim Report to Congress on Occupational Diseases," 3 (1980).

58/ Barth, P., "Compensation for Asbestos-Associated Disease: A Survey of Asbestos Insulation Workers in the United States and Canada," Chapter 5 in, Selikoff, I. J., "Disability Compensation for Asbestos-Associated Disease in the United States," Report to the U.S. Department of Labor, Contract No. J-9-M-8-0165 (June 1, 1982).

59/ Id. at 357, 395. On the other hand, the slowness of the system does account for the large number of claims (63 of 136) found still pending at death. Id. at 357.

Another basic finding of the Barth study was the "lack of usage of the various support schemes." Of the 84% of the workers who stopped working due to terminal illness, two out of three never filed a workmen's compensation disability claim. Id. at 346, 431. Death claims were filed in less than half of the cases (even when widows survived their husbands), despite the fact that almost all should have been eligible for awards. Id. at 375.

accompanying study, limited to New Jersey, of three groups of asbestos workers and their workmen's compensation experience showed similar results, with 64 of 72 decided claims resulting in awards.[60]

The asbestos worker studies demonstrate that when diseases are likely to be work-related, workers' compensation systems have been able to find causation and make awards. Claims that large numbers of workers go uncompensated are most likely, therefore, to reflect not findings about the inadequacy of the compensation systems to cope with meaningful causation evidence, but, more likely, the failure of workers to seek compensation or the absence of data confirming

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[60] The companion study of three different cohorts found:

Worker Group	No. of Asbestos-Related Deaths	Workmen's Compensation Claims Filed	Awarded	Denied	Pending
Large Asbestos Manufacturing Plant	74	40	38	2	0
Insulator Union Members	44	26	22	3	1
Wartime (1941-54) Insulation Plant	87	9	4	3	2

"Workers' Compensation Experience among Three Groups of Asbestos-Exposed Workers in New Jersey," Chapter 6 in Selikoff Report, supra note 50, at 436-93.

Another study of chronic lung diseases associated with beryllium exposure concluded workers' compensation systems provided compensation too slowly and with too much delay. Stoeckle, J.D., et al., "The Compensation Experience of Patients with Chronic Beryllium Disease," 17 J. Occup. Med. 167 (1975). The study did not, however, indicate any difficulties faced by the boards in determining causation.

claims of widespread disease causation. Unless employers are to be determined to be responsible for all diseases of their workers -- regardless of whether they can be shown to have caused them -- the absence of scientific data to support disease causation claims makes it difficult to fault the compensation system.

Professor Barth finds fully justified the reluctance of compensation boards to make awards when little evidence exists of association between on-the-job chemical exposures and disease:[61]

> Those diseases whose etiology is unknown should not be covered in the manner that currently prevails in most states. For courts or juries to decide etiological matters when science does not have any answers creates an unacceptable burden for them and necessarily results in capricious decisions ... .
>
> Claims involving heart disease or cancers where there is no "known" occupational cause would not ordinarily come into the system and when they did would usually be denied. As better information is found that links a form of disease to the workplace it should be added to the schedule.

In sum, the oft-repeated claim that persons diseased due to chemical exposures are unfairly going uncompensated cannot be supported by the facts. The ability of the torts and workers' compensation systems to provide warranted compensation has been much under-stated in many of the calls for new administrative compensation schemes.[62/]

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[61] Barth, P.S., Workers' Compensation and Work-Related Illnesses and Diseases 278-79 (1980).

A second argument that the torts system cannot meaningfully cope with chronic injury cases builds on the premise that lawyers and judges cannot deal with probabilities, as must be done if scientific knowledge is to be used to assess causation. However, as the discussion above indicates, there is no inherent reason why scientific evidence cannot be introduced into a courtroom, explained to judge and jury, and rationally evaluated. Claims such as -- "The lawyer recognizes no degree of causation; either Event A is a cause or it is not"[63/] -- misconceive the extent to which legal

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[62/] Some traditional barriers to obtaining compensation for chronic injuries have had to be changed to make such compensation possible. For example, statutes of limitation in both the torts and workers' compensation systems that would have precluded recovery because disease did not manifest itself until many years after exposure have had to be altered. Most states have thus adopted "discovery" statutes that allow suit within a few years after disease is manifest. Section 301(e) Report, supra note 2, at 28 (at least 39 states have adopted some form of discovery rule).

Another barrier unique to workers' compensation schmes still unfairly plagues workers in some states, namely the requirement that the disease be "peculiar to" the occupation. Such requirements arbitrarily prevent compensation for many diseases such as lung cancer that can be caused either by occupational exposures or other factors. See Harvard Note, supra note 6, at 92-22, 929.

On the other hand, rules in some workers compensation schemes that set minimum exposure requirements in terms of years of exposure, id. at 923-24, although perhaps sometimes in conflict with recent scientific evidence, represent a rough attempt to reflect the necessity for showing sufficient exposure to make disease causation more likely than not.

[63/] Large and Michie, supra note 12, at 595; also quoted in ELI Toxic Torts Study, supra note 1, at 10.

principles can be and have been flexibly adapted to use scientific data.

Every day in courtrooms across the country, lawyers make arguments to juries about the probability that some fact is or is not true. Arguments that, for example, car A was going 60 mph, exceeding the speed limit, and thus negligent, may not be expressed as probabilities, but no logical distinction can be made between the legal system's ability to decide that fact and issues of disease causation. If few courts have, as was done in Mahoney, carefully reviewed solid scientific data, it is not because they would be unable to do so, but because litigating lawyers have failed to present the evidence to them properly.[64]

Third, it is not at all clear that the requirement for expert testimony in chronic hazard lawsuits is out of the ordinary. Although an epidemiologist, toxicologist, or similarly trained individual would likely be necessary to make the sort of causation presentations discussed above, the need for such an expert is no greater than the need for engineers in many automobile product liability cases or for physicians in medical malpractice suits. In either case, lawyers and their experts must, as they have been doing for

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64/ Those few precedents, such as Miller v. National Cabinet, discussed supra note 50, may demonstrate an inability of some courts to perceive, their true role in assessing causation in chronic injury cases. The remedy for such failed perceptions, however, is not abdication of the judicial system, but, rather, better presentation of evidence to demonstrate errors in perception.

many years, develop means of explaining technical material to lay judges and juries.

Arguments that the expense of compiling evidence and hiring experts makes proof of causation prohibitively expensive for plaintiffs are often tied to arguments about the difficulty of bringing class actions in chronic injury/ chemical exposure cases. Class certifications have commonly been denied in such suits, primarily because the particulars of exposure and disease may vary substantially from person to person. However, the unavailability of class certification does not preclude litigating as a single undertaking numerous actions on behalf of similarly situated plaintiffs. Often, a number of plaintiffs, from a single plant or residing in an area near a hazardous waste dumpsite, are suffering from common chronic injuries they believe are due to chemical exposures. Even if the causation issues are not common enough to justify class action status, they will nonetheless be common enough that counsel can prepare very similar cases. Inevitably, if the first such cases to go to trial are successful, the chances of generous settlements in succeeding cases are high.65/

65/ The criticism of the tort system's handling of causation determination that excessive transaction costs may be incurred (and inequitable results achieved on some occasions) by the need to litigate the same basic scientific issues over and over in each case is also somewhat negated by the reality that settlements are likely in the wave of initial

(Footnote 65 continued on next page.)

Finally, others have argued that determining the cause of any person's cancer is impossible due to the "widespread dissemination of carcinogens."[66/] Although perhaps true in a very technical sense, such arguments prove too much. The issue for compensation purposes -- consistent with accepted legal principles that persons who more probably than not caused injury can and should be found to have caused compensable injury -- can be determined in light of accepted scientific data and principles.

In sum, the arguments that the tort system cannot cope with causation in chemical exposure/chronic injury cases cannot stand scrutiny. This article of faith repeatedly invoked to justify turning such cases over to an administrative compensation scheme, on the one hand, vastly overstates the evidence that persons are currently going uncompensated,

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(Footnote 65 continued from previous page.)

successful suits. Essential to any well-presented causation argument will be the dose-response curve against which plaintiff's exposures are to be assessed. For substances leading to repeated litigation, such as asbestos, once such assessments are made, relitigation would often not be necessary. The pattern in asbestos cases has certainly been one of most cases being settled; only those cases where causation is doubtful (often because plaintiff's lung disease had has been diagnosed as other than one with symptoms reflective of asbestosis) tend to go to trial.

66/ See, e.g., Trauberman, supra note 35, at 1. Trauberman's assumption that causation is beyond proof in chronic injury cases is belied by his claim that: "With toxic substances like asbestos, [establishment of cause-in-fact] is quite difficult." Id. at 3. As described at notes 9 and 10, supra, neither the underlying science nor the experience of trial lawyers has shown this to be the case.

and, on the other hand, underestimates the ability of plaintiffs to present reasonable cases demonstrating causation. As the success of numerous plaintiffs in asbestos litigation has demonstrated, when causation is likely to exist, recoveries are likely to be forthcoming. Although a few individual cases can be found where courts have been unwilling to accept solid scientific presentations demonstrating the likelihood of causation, the remedy there is not abdication of the torts system but education of the judiciary.

Although the difficulties of causation proof do not in and of themselves justify resort to an administrative compensation scheme, other factors may make such a scheme a more desirable means of adjudicating some chronic injury/chemical exposure cases. For example, the sheer number of pending asbestos cases may argue for more efficient decision-making through administrative action. There can be no doubt the clogged judicial system now handling such cases is both time-consuming and very costly, with administrative and lawyer costs typically exceeding the sums ever being recovered by plaintiffs.67/ Given that the impetus for administrative compensation schemes, especially for asbestos cases, will continue even if it is admitted that the tort

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67/ Various studies have estimated that more than 60% of insurance premium dollars never go to plaintiff's pockets, with the dollars being used to fund administration, lawyers and expert witnesses. See Interagency Task Force on Product Liability, "Product Liability: Final Report of the Insurance Study," 4-72 to -74 (1977).

system can reasonably cope with causation issues, it is valuable to review how causation is proposed to be treated in several currently proposed administrative systems.

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CONCLUSION

Scientific data can be employed usefully to guide decisionmakers in making chronic injury/toxic substance causation determinations. Whether such determinations are made in the common law tort system or in administrative compensation schemes, the data base available from epidemiologic and other scientific studies is invaluable to determining whether exposures have been sufficient to have doubled the likelihood that any person's disease was due to chemical exposure. Based on such data, fair and equitable compensation decisions can be made. Reliance on such data would be more equitable and more consistent with established scientific and legal principles than often-proposed presumptions of causation.

Pollution's "Invisible" Victims: Why Environmental Regulations Cannot Wait for Scientific Certainty

Remarks by the Honorable Douglas M. Costle,
Administrator, U.S. Environmental Protection Agency
Prepared for Delivery Before the National Coalition on Disease Prevention and Environmental Health
Washington, D.C., April 28, 1980

In 1937, a drug manufacturer decided the best way to capitalize on the popularity of the new sulfa drugs was to market one of them in a liquid, nonprescription form. He developed a product called Elixir Sulfanilamide, which combined a sulfa compound with diethylene glycol—a commercial solvent used in making antifreeze and brake fluid.

Because the drug control laws of the time did not require safety testing, the manufacturer was free to put his product on the market, and he did so—with devastating results. Although only 2,000 pints of the Elixir were produced, and only 93 were consumed, a total of 107 people died from the effects of the solvent.

The public outcry that followed prompted Congress to pass a new Food, Drug and Cosmetic Act—one that, for the first time, gave the Food and Drug Administration the authority to require the testing of new drug products for safety.

Under the circumstances, the public's outrage and Congress' response to it were scarcely surprising. The trail from cause to effect, in the case of the Elixir, was a short one. No great breakthroughs in the science of epidemiology were required to follow it. Once it was established that all of the victims had consumed the Elixir, the evidence pinpointed diethylene glycol as the cause of death beyond any reasonable possibility of doubt.

Normally, of course, regulatory issues in the health-and-safety area are not posed in such dramatic fashion. This is especially true for environmental regulation. There, the pathway from cause to effect—from the point where a pollutant is discharged into the environment, to the point where it can be positively connected to particular diseases in particular human beings—tends to be a long and circuitous one.

To be sure, there have been instances where environmental pollution has been directly and dramatically linked to public health disasters. The 1948 atmospheric inversion in Donora, Pennsylvania, which claimed 20 lives, is one example; the 1952 inversion in London, whose toll was 4,000 lives, is another. But on close inspection, even these turn out not to be exact counterparts of the Elixir episode. There's no doubt that air pollution was the culprit in both Donora and London—but even today, 30 years after the fact, we still cannot say exactly which pollutants in the air were to blame.

And such episodes are the exception. Most health-related regulation in the environmental field must be written with even less direct evidence of the linkage between environmental contaminants and their victims. The problem is illustrated by the example of cancer, where a series of major obstacles await anyone who wants to prove that environmental pollutant A—even if it is a known carcinogen—caused the disease in victims X, Y, and Z.

- First, cancer can remain latent for literally decades before identifiable symptoms begin to appear;

- Second, it can be caused by more than a single agent—as shown, for example, by the fact that asbestos workers who smoke are 30 times more likely to get cancer than their nonsmoking fellow workers.

- Third, except in rare instances, the various forms of cancer do not bear the clear imprint of a particular carcinogen;

- Fourth, our society's practices in terms of keeping records of cancer deaths, and their causes, have never been systematized on a national scale;

- And finally, few doctors have ever bothered to consider environmental pollutants as causes of cancer; and thus, they have not looked for evidence of exposure to cancer-causing agents in examining their patients' histories.

For other chronic diseases, the difficulty of establishing links to particular pollutants is at least as great as for cancer. And that, quite frankly, poses a problem for us. If we could routinely predict the number of people who were going to get sick from the discharge of a given amount of a pollutant, our regulatory decisions would be better—just as an investor's decisions would improve if economic forecasting were a more exact science, and a farmer's judgments about when and what to plant would benefit from better long-range weather forecasts.

But though we must operate in the absence of scientific certainty, we are by no means without scientific resources. For while we seldom have the kind of proof available in the Elixir episode, we almost always have the scientific equivalent of *circumstantial* evidence. This can take the form, for example, of tests that show how a pollutant affects laboratory animals; or studies of its impact on human beings exposed to it in the workplace, or in food products. Moreover, if we weigh that evidence in a careful and systematic way—the courtroom analogy is giving a suspect pollutant the benefit of due process—we are fully capable of making reasonable judgments about an appropriate degree of regulatory control.

Rather than talking about this process in theoretical terms, I would like to briefly describe how it has worked in the case of one particular pollutant—carbon monoxide.

Let me pause to emphasize that in choosing carbon monoxide, I don't mean to imply that it is a "typical" pollutant. First of all, there is no such thing; and second, carbon monoxide differs in important respects from other targets of environmental regulation, as I shall explain. But our experience with carbon monoxide does illustrate how we can make the best possible use of such scientific information as is available to us.

We began our review of carbon monoxide with the certain knowledge that, at high concentrations, it is dangerous. Uncounted numbers of people have proven that fact, in tragic fashion, by asphyxiating themselves on car exhaust.

However, our concern is not the tremendously high concentrations that result when exhaust fumes are piped into a closed vehicle—concentrations of thousands of parts per million of air. Instead, we were worried about the effects at the low concentrations found on busy city streets, which typically fall into the range of 10 to 50 parts per million.

In trying to understand these effects, we were blessed with a wealth of scientific information—in fact, we accumulated roughly 1,000 studies on how carbon monoxide affects human beings and test animals.

However, having a large amount of data about an elusive subject can often be less useful than having a small amount of data about a clear-cut subject—the Elixir phenomenon again. One study may contradict another; studies may prove to have flaws of one kind or another; or a single study may provide what seems like a highly significant finding, but its value is limited because no other experiments have duplicated the result.

Thus, in order to develop the best possible *scientific* basis for setting an air quality standard, we somehow have to sift through the mass of data in hand, weighing each relevant study in turn, and emerging at the end with a document—called the criteria document—that lays out the evidence in a rational and comprehensive way.

Preparing these documents is a massive undertaking, and one that does not lend itself to brief description. But at its core is a process that amounts to sending each bit of relevant evidence out into the harsh world of scientific review—a world that is *extremely* intolerant of sloppy methods or unjustified assumptions. This happens, not once, but several times during the prepartion of the document. The result is that any scientist with an interest in the pollutant—whether from industry, the academic community or citizens' groups—is given ample opportunity to comment.

Nor does the door close when the criteria document is published in final form. Once a standard has been proposed, we hold public hearings and invite written comment—which puts the evidence on the firing line once again.

We haven't gone all the way through to the point of proposal in the case of carbon monoxide. The final criteria document will be out shortly, but it will be several weeks before I propose a standard. Nevertheless, some interesting lessons have been learned in the course of preparing the document.

In 1971, when the first carbon monoxide standard was issued, it appeared the main health problem associated with the pollutant was that it tended to make people less alert. This is a potentially serious problem, considering that drivers are among those most likely to be exposed. However, studies done in the interim suggested that there was a more serious health concern—carbon monoxide's impact on the human heart.

Behind this concern lies the fact that carbon monoxide combines more readily with a blood constituent called hemoglobin than does oxygen. Since hemoglobin is what carries oxygen from the heart to the rest of the body, the formation of carboxyhemoglobin, which is what you get when carbon monoxide and hemoglobin combine—forces the heart to pump more oxygen than normal. This in turn, leads to an increased incidence of angina—a painful condition that often requires the use of medication, and sometimes requires victims to be hospitalized.

Yet knowing that angina was the principal health effect we needed to be concerned about was not enough. We also had to know how much carbon monoxide the body could handle without aggravating angina. There were several studies suggesting it became a problem when between 2.5 and 3 percent of the hemoglobin had been converted to carboxyhemoglobin. However, one study suggested that the threshold was, in fact, under 2 percent.

The problem facing the Agency was, how to weight *that* study in comparison with all the others. This was an issue where we needed the benefit of expert opinion from outside the Agency; and where, as the result of our review procedures, were able to obtain it.

The Agency has a special panel of scientists—called the Science Advisory Board—whose specific assignment is to provide a check on the scientific foundation underlying the rules we write.

Members of the board with particular expertise in carbon monoxide were asked to review the draft criteria document.

When, as part of this review, they looked at the study in question, they concluded that it had a potential flaw—the fact that there were other contaminants in the air beside carbon monoxide during the experiment. They recommended, therefore, that we not use this particular study in deciding on the likely threshold for the aggravation of angina.

This is a snapshot look at how scientific review works in practice. It should not be viewed as typical. We cannot, either as a matter of law or of common sense, approach the regulation of a pesticide intended for use in one small corner of a single state the same way we deal with an air pollutant found in every city and town in the country.

But whatever the target pollutant, our commitment to establishing a sound *scientific* basis for regulation remains constant.

Yet, for every pollutant, there also comes a point where the scientific knowledge available can offer only guidance for regulatory decision-making—where policy judgments must be made. In regulating air pollutants, for example, the Clean Air Act tells us to allow for a margin of safety—to set the standard somewhat lower than a strict reading of the evidence might seem to call for. And deciding where to set the margin—although reflecting the scientific evidence—ultimately comes down to a question of judgment.

I can't say yet where the margin will be set in the case of carbon monoxide. But our basic approach in making such judgments has been basically this: If the evidence clearly *suggests* the possibility of health damage, but is not conclusive, we will *assume* that the possibility is real.

Again, cancer offers an illustration: Since medical science has not demonstrated that there is a threshold for carcinogens—a dosage so small it can *never* cause cancer—we assume there is no threshold. That does not mean we strive for the unattainable goal of zero risk in regulating carcinogens. But it does mean we are concerned about these substances even when they are present in the water, the air or in soils at very low concentrations.

Why have we adopted this kind of stance? Simply because if we wait for scientific proof before taking firm regulatory action, we will very likely turn out to have waited too long. Thus, with carbon monoxide, we do not have proof that angina leads to permanent heart damage—but there is evidence that it may, and we must take account of that evidence. And the dangers of delay are demonstrated still more graphically by the new class of pollutants that increasingly concern us—pollutants that are products of the post-World War II Chemical Revolution.

This revolution has produced an extraordinary array of substances that, unlike carbon monoxide, have never been known in nature. These substances—synthetic organic chemicals—have helped make our lives more comfortable and more rewarding in many ways. They have saved lives, they have increased crop outputs, and they have generated a vast family of new industrial and consumer materials. But some of them have proven to have unintended and tragic impacts on the lives of people and on the quality of the natural environment—as we learned through our painful experience with DDT, Kepone, PCBs, thalidomide . . . and Elixir Sulfanilamide.

We of course have only a limited sense how dangerous these substances are. We assume very few will ultimately turn out to be toxic. Yet the universe of substances we are talking about is a large one—an estimated 5 million chemicals are now known to exist, and 45,000 of these are in commercial use. Moreover, the *quantity* of synthetic chemicals has grown exponentially over the past few decades—with production rising from less than 50 billion pounds in 1950 to more than 300 billion pounds by the late 1970s.

If nothing else, those figures argue for treating these substances with a generous measure of caution. As Love Canal taught us, a careless attitude at one period in history may turn out to impose heavy costs—both in financial and in human terms—more than a generation later.

Given the potential for long-term damage, it seems to me the case for a policy that emphasizes protecting health where the scientific evidence is inconclusive *should* be irrefutable. Yet, as many of you know, it's getting more and more difficult to carry that argument in Washington these days—given the antiregulatory climate in town.

The counter arguments vary. At times, agencies like EPA are accused of failing to do their scientific homework properly; at times of stretching their interpretations of the evidence to support unreasonable regulatory measures. But whatever the particular line of argument, the basic message is the same—we should slow down, wait for more evidence, conduct more studies.

We *do* need to improve our scientific understanding of the links between pollution and health—especially in the case of toxic chemicals, many of which didn't exist a generation ago. But we cannot delay writing sensible, balanced rules governing these substances. We know enough to do that. Moreover, if new evidence emerges to suggest the need for changing our rules, we can change them.

In my judgment, it is not the quality of our scientific work—nor our interpretation of it—that makes it difficult for us to meet the arguments of those who would have us move more cautiously. It is rather the fact that only rarely can we identify specific groups of people whose health has been demonstrably affected by environmental pollution. Instead we deal in the statistics from computer-generated probability studies, and in phrases like "excess cancers per million population"—scarcely the stuff of which newspaper headlines and TV documentaries are made.

Yet the threat to human health represented by environmental pollution is not diminished because it lacks the drama of an Elixir Sulfanilamide tragedy. So it seems to me that one of the chief tasks facing all who are concerned with environmental health is quite simply to convey to the public, in any way we can, some basic facts about the links between pollution and health: we must say, in candor, that there are limits to what science can tell us about this relationship; but that the more serious limitation is an inability to see the suffering that lies behind the dry projections of injury that science does permit us to make; and that, if this failure of vision can be overcome, the need for firm and farsighted environmental regulation will be very plain to see.

William Lowrance: probing societal risks

In his person he seeks to meld the creative tensions of the arts and sciences. When he isn't painting with watercolors or designing jewelry in gold and silver, he can be found at his desk writing his second book. The theme of this book is the leitmotiv of William W. Lowrance's life as a public-policy thinker: the ethical issues in science, medicine, and engineering.

His life's work wasn't always thus, although fascination with the science-policy domain tugged at him from junior high school days. Initially, Lowrance pursued a traditional path in science. In 1970 he received a Ph.D. in organic chemistry and biochemistry from Rockefeller University in New York City. For the next year he worked at Eastman Kodak as a research chemist, ending his career as an industrial chemist with a patent for synthesizing phenyl esters.

But then the tug became too great. Eschewing a hybrid career of research scientist and science-policy thinker, Lowrance decided to devote all his efforts to the latter endeavor.

Today he is director of Rockefeller University's new life sciences and public policy program, but the stops along the way were many and varied: research fellow at the National Academy of Sciences, where he wrote the well-received book, "Of Acceptable Risk: Science & the Determination of Safety"; special assistant to the undersecretary of State for security assistance, science, and technology in the Carter Administration, where he was involved in the decision to burn at sea thousands of tons of agent orange left over from the Vietnam war; and visiting professor at Stanford University, where he directed the policy courses in the program in human biology.

Whatever the way station, Lowrance has always pursued a humanistic approach to the study of the scientific and technological elements of contemporary problems, especially setting his probing mind to the thorny issue of societal risk.

Certainly the unsettling seventies, a renaissance period for regulatory activism, left no sector of society untouched. A patchwork quilt of laws was enacted to govern consumer products, safeguard workers, protect the environment. Unfortunately, the resulting plethora of consumer warnings, health scares, and environmental lawsuits has drawn society into a "regulatory catalepsy," Lowrance says.

To extricate us from this state, to disabuse us of the myth of a risk-free society, he urges a systematic assessment of hazards. In this interview with C&EN associate editor Lois R. Ember, Lowrance focuses on the land disposal of the toxic chemical remains of our industrialized society. He discusses the major components of this assessment—characterizing risk, setting stable priorities, accommodating scientific and lay perceptions of risk, and weighing risks against costs and benefits.

C&EN: Would you define acceptable risk in a generic sense, and then more specifically as it applies to human exposure to toxic waste from a chemical disposal site?

Lowrance: Well, in a general sense, I have been seeking to find some way of describing what we do when we as a society decide to endure a risk, reduce it, or spread it in some way through society. And I have used the term acceptable because it is a useful way to organize one's thinking. It implies that part of a personal or social decision has to do with the likelihood or consequences of ill effect from the risk. Quite separate from that is one's value judgment about the risk—whether it is acceptable or not. So there are two separate mental or social functions: to decide what the risk is; then to decide what to do about it. Of course the term has several different meanings. One, in a somewhat stoic way, people simply endure the risk without complaining. They see no alternatives, and decide that for whatever reasons the hazard is just tolerable. A second meaning is that people know essentially what the risks are, but decide to accept them. Smoking is probably a very good example of that. At the other end of the spectrum are risks that we see as absolutely intolerable, such as chemicals or radiation that cause birth defects. In this case, it is more useful to speak of unacceptable risk, and we as a society or a subgroup of society decide to do something about reducing the risk. Of course, the ranking of a risk as acceptable or not is not an absolute line at all. Sometimes we worry about hazards that are not so risky as some others, and we probably let some hazards go unattended that we would worry more about if we really examined the statistics. As the term acceptable risk applies to toxic waste sites, I think that issue is still quite immature. We haven't had a chance to decide what the health and environmental risks are for many sites. It's very clear that sites differ greatly in their chemical content, in their underlying geology, and in the

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I've found the word safe not to be a very useful word . . . everything has risks under some circumstances to some people

potential for human exposure in the neighborhood of the site. Thus we are some distance away from being able to make summary statements about the acceptability or unacceptability of waste sites for the nation.

C&EN: For the nation, in a general sense. But can it be done for specific sites?

Lowrance: Yes. I think it has to be done for individual sites. Obviously, if we decide to do nothing about a site, to leave it as it is, we are accepting that site. On the other hand, if communities decide to do something about the site, to monitor any leakage from the site, to do health studies or environmental studies on exposed populations or environments, then they are taking action on deciding about the acceptability of that site.

C&EN: Would you equate acceptable to safe, in a generic sense?

Lowrance: No. I've found the word safe not to be a very useful word. I prefer not to use it. Everything has risks under some circumstances to some people. So, I prefer to speak of risk level and risk acceptability.

C&EN: At this time, is it possible to rank the risk from exposure to chemical landfills relative to other societal risks?

Lowrance: Not yet. I feel that very strongly. It's much too early to be able to know what the risks really are. Again, I want to emphasize that there are a great number of sites and they are very, very different from each other. There has not been time to study many of those sites in any detail technically. In many cases, they're full of horrible—sometimes unknown—mixtures of chemicals. The chemicals, of course, have undergone changes since they were put into the landfill, so we don't know what's in the landfill, much less what the effects on human health or the surrounding environment might be.

C&EN: But knowing what we do know about one site—Love Canal—can we rank the risk of living near it to the risk of living near a nuclear power plant, or driving a car on a New York City street at rush hour?

Lowrance: I'm not able to yet. I think eventually we will be able to. But it seems to me that one of the problems in this area is that chemical waste sites have been treated as an exotic issue, as a special source of chemical exposure for human beings. I think the only way out of this problem is to integrate it into our general considerations of air and water pollution. And until we are able to know what contribution waste sites make to overall chemical contamination of groundwater or municipal water supplies or domestic wells, I think we really won't be able to compare them to other chemical risks, much less to the risk of airline travel, coal mining, nuclear power, specified consumer risks, and so on.

C&EN: How do we begin to weigh burden of risk from chemical dumps against programs designed to defend against those risks? How do we begin to define hazards and agree upon goals?

Lowrance: The first thing we have to do is learn more about potential health and environmental effects from the dumpsites. And until we know that, it's going to be very hard to appraise the overall social burden from those waste sites.

C&EN: What elements would you put into that calculus? Risks? Costs? Benefits?

Lowrance: In the overall societal calculus, I certainly would use all of those things. I would use the human health risk, the general environmental risk, the benefits of the chemical industry activity to society, the special problems to local, affected populations, special effects on workers at the waste sites, and so on. I would then want to know the costs of all the possible remedial actions or alternative activities for coping with the waste.

C&EN: Do you think it's possible now?

Lowrance: No. We are nowhere close to being able to do that in a satisfactory way. The first thing I would like to see us do is try some assessments on representative but different kinds of waste sites. One hears estimates for the number of waste sites in the U.S. ranging in the thousands or even several tens of thousands. It seems to me we should select 12 or 15 different kinds of sites—geologically different, environmentally different, and so on—and do an estimate of the overall projected environmental and health hazards. Then put those in context with the benefits of that chemical activity. Also, perhaps, look at the relative cost-effectiveness of different ways—recycling, incineration, or ocean disposal—of disposing of that waste at that site or elsewhere.

C&EN: What are the constraints to carrying out studies on comparative risk and risk-reduction effectiveness of large government programs such as the Resource Conservation & Recovery Act (RCRA) and superfund?

Lowrance: Well, first of all, I don't think we have the needed basic information. First, we don't have much information on the chemical content of many dumps, or the migration of that material. Second, we don't have much information on the engineering of the dumps and the geology at the sites. And third, we don't know enough about how to assess health effects to surrounding exposed communities. And until we know these things, it's going to be very hard for us to compare one site with another for remedial attention, for monitoring, or fcr further health studies. A lot of preliminary research needs to be done, and I don't have the sense that it has been done yet. There are probably some clear public health emergency sites that do need attention under superfund and RCRA. But I would like to see us hold off on spending all funds available under the two programs until we have a better idea of where the priorities ought to be set. And I understand that there is substantial effort going on, not only within the Environmental Protection Agency, but also within the states to "prioritize" sites.

C&EN: As a society we are setting agreed-upon goals for certain activities; can you give some specific examples?

Lowrance: We have taken major actions over the last few years to control the manufacture and dispersal of polychlorinated biphenyls (PCB's). We have taken actions to reduce our exposure to 2,4,5-T and its dioxins. We have reduced the manufacture of and the spraying or industrial use of these compounds. We have taken strong precautions in the disposal or destruction of these compounds. And, in the case of PCB's in the Hudson River, we are taking remedial cleanup action to remove them from the general environment. In that process, we have raised a series of caution flags, not only against future use of these compounds, but compounds that are like them or likely to be like them in their persistence, in their health effects, and so on. We have begun to take specific, even costly actions against these compounds.

C&EN: But that was after the fact, after they had been dispersed. Are we doing anything as a society now to set agreed-upon goals, to avert future PCB-like problems?

Lowrance: Yes. I think what's happened with a whole series of incidents following assessment of certain persistent pesticides and the compounds that I just named is that we have identified categories of environmental and health effects in these cases as being intolerable or barely tolerable to society. There is very strong demonstration value here. For instance, as an industry begins to develop a new product line, it will think very hard about whether that particular chemical product line resembles chemicals that we have drawn boundaries around and tried to eliminate from our food supply or air and water environments. I would like to make one additional point. Sometimes people say that it's lamentable that we spent so many years and so many dollars arguing over this or that pesticide, in this or that set of hearings before EPA or the Agriculture Department or the Food & Drug Administration. But they forget that the demonstration value, the pilot value, of those deliberations far exceeds the mere number of dollars or even lives saved from that one chemical because it sets precedent. And we don't have to go through the same hearings, the same development of scientific evidence, for analogous compounds in the future.

C&EN: Well, that was the Occupational Safety & Health Administration's argument in trying to promulgate its generic cancer policy, which it wasn't very successful in doing.

Lowrance: Right. I think it's very hard to do. We have not developed firm generic criteria in any single area of chemical exposure. I certainly acknowledge that. But we have made real progress in indicating some categories of possible insult that most Americans are not willing to tolerate. It's a much softer kind of indication than a printed generic policy on classes of compounds, but I think some guidelines are becoming much clearer.

C&EN: How would you begin to set priorities for the cleanup of existing landfills?

Lowrance: I would like to see us practice at several different landfills around the country. In those demonstration assessments we would want to consider the geological situation and the engineering design of the landfill. The second thing we would want to think about is actual exposure to human beings. Exposure assessment is one of the most uncertain and tricky areas in this whole business. It doesn't matter so much to us that a chemical is in a dump, what matters is whether human beings are exposed at any significant levels to it over time.

C&EN: But even if we do set priorities at these demonstration dumps, how can an agency take action in an unknown situation—an abandoned dump—where it doesn't know the geology, it doesn't know how far the chemicals have migrated, it doesn't know whether there has been human exposure?

Lowrance: I think the agency would want to begin with a geological survey, with analysis of the chemical contents of the dump, and with monitoring or modeling human exposure to chemicals from the dumpsite. It would go through that list of assessments, and then back that up with reviews of historical records, the company's own records of what was put in the dump, how the dump was treated over time physically, and so on.

We have not developed firm generic criteria in any single area of chemical exposure

C&EN: Is EPA setting what you have called "protectable priorities?" And would you define that phrase.

Lowrance: In some of my writing, I've said that agencies need to set priorities for their actions and indeed those priorities need to be "protectable." That is to say, once the agency, with the full mandate of Congress and the Administration, begins to pursue a course of protection, it is able to stay with it long enough to do a good job, and is not diverted by minor distracting affairs that can overwhelm the organization. With the change of Administrations and the apparent rethinking of superfund, I can't say whether EPA is setting or will set protectable priorities. During the Carter Administration, however, EPA under superfund sought advice on setting priorities. Mitre Corp. in Virginia was commissioned to do a background study on the criteria for setting priorities among waste-disposal sites. So there has been some thinking about the way we might go about picking the worst of the sites for early attention under superfund.

C&EN: If the effects of exposure to a particular chemical are deemed to be intolerable, and the chemical is known to be buried in the landfill, is it appropriate to apply the degree of risk—what you call the "risk ceiling" for that chemical—to the landfill as a whole?

Lowrance: I think, again, that's a matter that depends on the chemical and the characteristics of its burial site. There may be traces of arsenic or cyanide or PCB's in the dump, but the action taken may depend on the integrity of the dumpsite itself. If the chemical isn't leaking from the site, perhaps the best thing to do is to leave the chemical in place, but monitor the site over a long time. On the other hand, if the housekeeping of the dump has not been very tight, and there is a high volume of PCB's in the dump, then action as severe as digging up part of the dump, removing it, and extracting some of its contents may be warranted. I don't think there is any one formula that can be applied to all situations.

Risk ceiling is the upper bound of the amount of a chemical we as a society deem tolerable. Beyond that bound, exposure to the chemical would be considered intolerable

C&EN: Would you elaborate on your concept of risk ceiling?

Lowrance: Yes. Risk ceiling is the upper bound of the amount of a chemical we as a society deem tolerable. Beyond that bound, exposure to the chemical would be considered intolerable. In some cases, we have set ceilings for risks, though usually not against any one discrete individual hazard such as an automobile or a pharmaceutical. What I have noticed is that some government agencies have regulated ceilings for an entire industry or endeavor, such as nuclear power generation, and have said essentially that they will consider all nuclear accidents larger than this scale and probability unacceptable. In effect they have set a ceiling for some overall activity in society, which manufacturers of individual equipment keep in mind as they design their own component of that national enterprise.

C&EN: An analogous situation, then, would be for an agency such as EPA to set ceilings for classes of chemicals that it would take action on if they were found in a landfill.

Lowrance: That's right. Either classes of chemicals or classes of health effects. That is, for example, air pollution in cities should not cause more than a certain amount of specified respiratory illnesses.

C&EN: This has not been done to date, has it?

Lowrance: Not really, no. It's implicit in some of the laws and it's certainly explicit in some of the things that municipalities or industries have done. But it often is not explicitly stated as a ceiling.

C&EN: Should we then as a nation begin to write our laws explicitly to set risk ceilings?

Lowrance: I think in some cases we can begin to do that. There are two considerations. First we have to get beyond the myth that some things can be risk free. We have to admit that various things we do in society have risks: that generating electricity has its risks, that transporting people has risks, and so on. That's been done in some areas, particularly in the food and drug area. Recent FDA decisions involving several hair dyes and residual diethylstilbestrol in meat have explicitly recognized a residual harm in a product, but have allowed that product to remain on the market under certain conditions. That's the first thing being explicit does: admit that there is risk. The other, then, is that we can deliberate about what levels of risk we are willing to endure for certain product classes or for certain kinds of activities—again, such as making energy or flavoring our foods. I don't think we are going to be able to do this for chemical waste anytime soon, partly because waste has a negative connotation. The activities that generate the chemical-waste risks, of course, are very beneficial to society in general. But waste itself, by definition, has very strong negative connotations, and it's hard to talk about the positive, social "value" of that waste.

C&EN: Should we take a breathing spell until we can address the chemical waste problem in a deliberate manner?

Lowrance: First of all, we may have studied some sites in sufficient detail that we can identify them as needing attention right now—that is, they are releasing substantial quantities of known dangerous chemicals into the environment to which people are being exposed. Some sites currently are under very close scrutiny and may well warrant cleanup and remedial action. Secondly, for various political and social reasons we may wish to go ahead and clean up some sites because local pressure is demanding such action.

C&EN: Well, that goes back to an earlier statement that you made, that sometimes we attack problems that have very little risk but have so much emotional value attached to them that we tackle them and ignore more risky problems.

Lowrance: One of the major difficulties that our modern society confronts is the problem of expert perception of risk as compared to lay perception of risk. And remember that a Nobel Laureate physicist is a lay person when it comes to assessing chemical-waste-site health risks, and a dean of a medical school may be a lay person when it comes to assessing the risks of a nuclear power plant. So I'm not just saying scientist versus nonscientist. But we do have difficulty as a nation in dealing with problems in which there are many different perceptions of the magnitude of the threat to society.

C&EN: How do we begin to bridge the difference between expert perception and lay perception?

Lowrance: I think that's one of the most important things for us to begin to try to do. I'm beginning to see some hopeful signs. At the recent Rockefeller University symposium on the assessment of health effects at chemical disposal sites, Morton Corn of Johns Hopkins University described approaches that teams of experts, government officials, and industry are taking at Memphis, Tenn., dumpsites. Here, as the assessment of the contents of the dumps proceeds, so does the planning for health studies and remedial action. Officials are meeting—as often as once a month—with local citizens and representatives of special-interest groups from that area. And I find that a very useful way to proceed. More generally, federal agencies are holding more public hearings on their research protocols, their priority setting, and their thoughts about regulation. I think that's healthy, too.

C&EN: Would you agree that the public outcry and political clamor has catapulted the issue of hazardous waste dumps out of the scientific realm into the political arena, that the issue has, in Alvin Weinberg's phrase, become trans-scientific?

Lowrance: Well, certainly public attention has come to the issue and the media has amplified that attention enormously, sometimes responsibly, sometimes not so responsibly. I personally don't find the term trans-science very useful. It means different things to different people. All these issues are hybrids of social and more technical components. And I don't think they can ever be divorced.

C&EN: Well, isn't that in part what he means by trans-scientific?

Lowrance: I think he means by that term to refer to decisions that inherently are scientifically unknowable. For instance, in his earliest papers he referred to cases like Hoover Dam. We will never test Hoover Dam to the breaking point. Therefore we will never really know the scientific probability of failure of Hoover Dam. We can estimate by using models, but we can never test the dam completely because we simply can't test it to its own ultimate failure point.

We have difficulty as a nation in dealing with problems in which there are many different perceptions of the magnitude of the threat to society

C&EN: But you would agree that the hazardous waste issue is now more in a political realm than a scientific realm.

Lowrance: Yes, but you see, going back to the word trans-science, I think Weinberg is referring not to things that are "not science," but to areas in which science inherently fails to reach. But certainly issues such as those of waste disposal are hybrids of social, ethical, political, legal, and economic concerns as well as technical and medical concerns.

C&EN: Well, then, what hybrid governmental/nongovernmental approaches do you see evolving to address the problem?

Lowrance: First of all, I'd say that economic and legal and ethical considerations are discussed in government, in industry, in special-interest groups, and in labor unions; not one of these organizations concerns itself solely with scientific or political or legal or social issues. Certainly the federal government is not the only government entity dealing with the waste issue. In fact, on this kind of issue, the problem is intensely special to the affected locale. So municipal, county, and state governments are working very hard on this issue, quite apart from the federal government (though sometimes with it). States are developing task forces for dealing with existing sites or with siting criteria for the future; this is being done in consultation with federal agencies. Secondly, I now see some useful task forces involving government, industry, citizen groups, and others. In California, the state government sets up a protocol for study of a waste site, but the industry does the study, performs the analyses, and, in consultation with state authorities, conducts

I would like to see better management of scientific assessment so that we can anticipate problems

the overall assessment. The state for its part maintains random-sampling quality control, checks the integrity of records and calculations, and in an iterative way stays in touch with the assessment. That seems to me to be a constructive model, and I have heard both from members of industry and the government there that the approach works.

C&EN: What is the scientist's role in making crucial decisions to reduce or eliminate dumpsite crises?

Lowrance: One of the things I'm concerned about is that we bring a little more stability to our social decision making. You have used the word crises quite fairly. Authorities, including scientific and health authorities, have generated crises from time to time, including at waste sites. Sometimes it's justified; other times I'm not so sure it is. I would like to see better management of scientific assessment, so that we can anticipate problems as well as try to avoid ringing the alarm bell prematurely. That's hard to do. It's quite natural for authorities responsible for a situation to become alarmed, to take conservative action, to raise the alarm before there is certainty that people are going to be harmed.

C&EN: How can scientists make a contribution to better management of scientific assessment?

Lowrance: Scientists can contribute by continuing to remind public authorities—scientific or otherwise—of what the possible and relative health impact or environmental impact might be from various hazards. If they see authorities becoming very concerned about an issue, technical people often can put it into context. I think that a constant attempt to develop a societal sense of the relative magnitude of hazards is a contribution scientists can and should make, whether they work as officials themselves or as advisers. Another role for scientists is to continue to press to keep the quality of the science very high. Again, that sounds like a platitude. But we've seen examples in the waste-site arena of scientific information that was released prematurely or experiments that were not well designed. The scientific community can contribute by insisting on continual review of scientific work, even if it is not their own, and by maintaining the pressure for high-quality assessment.

C&EN: Does the scientist's role end with an assessment of the relative magnitude of the hazard and the assurance of high-quality science, or can he or she contribute to the crucial decision-making process?

Lowrance: Scientists have those two roles. Beyond that, deciding whether some hazard is too great for society to bear, or whether some course of action should be taken, or whether legal liability should be levied is not a matter for science as science. However, people who are technically trained may be called upon—either as appointive or elective officials or as members of advisory bodies—to take stands and judge for society what is acceptable and what is not. But in making judgments of that kind they should be aware that they are making value-laden social judgments.

C&EN: Then technical people can help the public understand the risks, thus enabling it to make the decision about acceptability?

Lowrance: Yes. Though in general that has not occurred. Although when apprehension about Love Canal was at its height, the governor of New York convened a panel chaired by Lewis Thomas, a very respected medical researcher and writer, to review the scientific situation at Love Canal. I think the publication of the Thomas review, which was amplified by the *New York Times* and other news media and was discussed by a number of different groups, probably had an interpretive ameliorating effect on that public situation.

C&EN: Except the review was very deficient.

Lowrance: True. I'm saying that I think the mechanism of having a panel of respected health experts was a good thing. I thought the review itself was slender—it did not go into the various technical questions in enough detail, it didn't document its conclusions very well, and it didn't recommend more effective studies that could be done. And I don't think it helped place the dumpsite situation in perspective.

C&EN: Would you expand on your views of allowing technical experts to lay out the risk involved in a situation, but then stepping back to permit the public to make the decision of risk acceptability?

Lowrance: As the hazardous waste site issue becomes more mature, as task forces do their work, the organized public is getting more of an opportunity to press for understanding and interpretation. In the public hearing process, there's plenty of opportunity for asking questions and challenging evidence, and this is often reported in local newspapers. Technical authorities have every opportunity to explain in straightforward terms what's going on at a waste site or what kinds of studies they are undertaking.

C&EN: Except that the impetus for this is the cry from the public, not from the experts. It's a mechanism that is evolving but it's evolving because of the public clamor for answers.

Lowrance: There is impetus from several directions. But certainly, the public is calling for studies of these waste sites and, as I said, the public is often right. The public is right to call for better planning for the future, examination of options, and so on. I think, too, that technical experts of many sorts have pressed for review. I don't think the impetus for public scrutiny of waste sites comes solely from public outcry.

C&EN: Can you give examples of experts that have pressed for review?

Lowrance: Advisory bodies to EPA and other government agencies have been concerned about these issues. There has been substantial discussion in the National Research Council and National Academy of Sciences about this issue. I understand that the Chemical Manufacturers Association has had a task force for several years on assessment of existing waste sites, and there has been substantial sharing of experience among the members of industry. Partly because of the public outcry, a lot of industries have undertaken review of their existing or even past waste sites. A lot of technical people have come to realize that this is an issue that has gotten too little attention for too long. So I think the impetus for a study of waste sites has come from many sources.

C&EN: You have written that crises or what you call "risk-related instabilities" arise as much from changing societal attitudes and evolving decision-making processes as from imperfect technical analysis and performance. Would you elaborate on this, especially as it could result in confrontations between industry and governments?

Lowrance: Our values have been changing over recent years partly because we live long enough now to have the luxury of worrying about some risks that in an earlier time in our history we didn't have to worry about. More people live to a later age, and the pattern of illness has changed substantially. We've conquered a lot of diseases like tuberculosis and polio, and we have reduced the threat of many infant diseases. In many ways, we have buffered other threats such as natural disasters like floods and hurricanes by technological advances, including warning systems and better construction. Secondly, there was a time in this country when there was a lot of open space and one could discard things without thought—dump them in the river, out in the desert, or on the back forty and forget about them. That's not possible any longer—land is more scarce, and peoples' values about the use of land and possible health effects from chemical exposure have changed.

C&EN: Would you address the problem of confrontations between industry and governments?

Lowrance: It's a kind of paradox. On the one hand, we have confrontations over the risks of dumpsites because we suspect that the chemicals in the dump cause health problems but we are not absolutely certain. So we have heated discussions because we know enough to be apprehensive, but we don't know enough to really assess the situation as thoroughly and as quickly as we would like. And because we now understand so much but not enough, we worry. So the paradox: We get into confrontation because we don't know enough to know what the situation really is; conversely, we worry more now because we understand that exposure to chemicals causes disease.

We know enough to be apprehensive, but we don't know enough to really assess the situation as thoroughly . . . as we would like

C&EN: Does legislation such as RCRA and superfund set up this confrontation—usually in the courts?

Lowrance: By developing a framework for argument, legislation almost by definition causes confrontation, though parties who believe they are being injured can still sue other parties, quite apart from this regulatory legislation. Even if we didn't have superfund or RCRA as laws, there still would be a great number of lawsuits pitting local citizens against municipal governments who have allowed or have developed chemical landfills, or against the industries that have dumped the chemicals. But when we passed these two laws we set up an identifiable framework for that confrontation. However, instead of it taking place in the tort courts, confrontation is occurring in a quasi-judicial scene—in agencies like EPA.

C&EN: There have been repeated calls for government-sponsored scientific advisory panels to which technological disputes could be appealed. Would you discuss the concept, especially as it might be a mechanism for separating the scientific and technical determinations from the political and social?

Lowrance: A number of people and a number of organizations over the years have called for technical courts of appeal or scientific tribunals to which scientific judgments could be referred, particularly technical calls in the course of a regulatory dispute. And there were some of these back even in the earliest days of the President's Science Advisory Committee in the 1960's. Disputes over 2,4,5-T went to that committee as did other questions where there was great scientific uncertainty and where the public problem was potentially a large one. Some people, of course, have proposed a national science court—something like a supreme court for refereeing scientific truth. In the past year or so, groups such as the American Industrial Health Council and several members of Congress have proposed a regulatory science corps or a national science panel, comprised of technical experts who could rule on food and drug science issues such as

I just don't know how to apply cost-benefit analysis to a toxic waste site

saccharin or Laetrile, or occupational safety and health issues such as vinyl chloride, or on consumer issues such as spray cans or the Pinto automobiles or even on a Love Canal situation in which there is great dispute over the science.

C&EN: These courts would advise only on the science, not on the political, social, or ethical overtones. They would, then, be a mechanism for separating the science from the political and social determinations. Correct?

Lowrance: Most of the proposals would be a way of separating the scientific judgments from social judgments. I personally don't believe those two can ever be separated completely. For instance, even in setting the ground rules for what is to be determined by a supreme court of science, one already is making social judgments. I'll use the hypothetical example of a waste-site problem. If that high authority took it upon itself to review the waste site and only considered the cancer-causing properties of the chemicals and did not look at possible reproductive health threats, even by setting its own rules for review, it already has made a social judgment: Cancer is what is important and reproductive issues are not so important. The other point I would make is that one can propose developing a science court that would also serve to make judgments for society. Some people have proposed that these courts be open about it and say that they are judging not only the technical part but also the social issues.

C&EN: What would happen to the quality of science in this process?

Lowrance: I think we need to try to improve the quality of science brought to bear on public decisions, regulatory and otherwise. I believe that having high-level review panels in government or industry or hybrid organizations is in principle a very good thing. And I argue for scientific pluralism. When an issue becomes important, a number of different bodies ought to review it.

C&EN: What about the issue of hazardous waste dumps?

Lowrance: I don't see any special role for a national panel to review it. I think the issue of hazardous waste has so many different components—some of them having to do with geology, some with engineering, some with reproductive medicine, or with epidemiology, or with toxicology—that I'm not sure a standing national panel can resolve the issue. On the other hand, I think national studies, such as those by the National Academy of Sciences, for example, should be encouraged.

C&EN: Other than structuring debate, is there value to cost-benefit analysis that overcomes the inherent problems and frequent abuses associated with the use of this technique?

Lowrance: There is no single technique that one can refer to as cost-benefit analysis. It's a whole cluster of many different specific approaches to the weighing of costs, risks, and benefits. And I don't see that any one approach has been sanctified yet. I think that its principal value is to lay out the questions clearly, describe the assumptions made in various approaches to analyzing the problem, and then put forth some statements or calculations that are open for criticism.

C&EN: Is there a risk-decision model preferable to cost-benefit analysis?

Lowrance: An alternative might be cost-effectiveness analysis. In this technique, one decides what the social objective is, and then compares the cost-effectiveness of the alternative ways of getting there. It doesn't have to take into account any measure of the benefit to human life. Once the goal is decided, one can make the social management decisions without having to get into any arguments about the worth of human life.

C&EN: What is the best way of relating the cost and benefits to risk? Using cost-benefit analysis or risk-effectiveness determination?

Lowrance: I think I would prefer the cost-effectiveness approach. I just don't know how to apply cost-benefit analysis to a toxic waste site.

C&EN: How do you view the repeated calls for the use of cost-benefit analysis in laws and regulations?

Lowrance: Well, the calls for use of cost-benefit analysis as part of regulatory proceedings certainly have become the vogue. In many cases it is seen as a panacea. I'm not sure that it is. First of all, it's already done in many cases in a very broad way.

C&EN: Are you alarmed by the repeated calls for its use?

Lowrance: I guess I'm not alarmed by them, but I think they are naive in many cases. I think the people who call for them most strongly are usually people who have never tried to do one. It's a very difficult business. And I think the people who like cost-benefit analysis as a method usually are those who find that the analysis comes out in their favor. □

CHAPTER III

COMPENSATING THE VICTIMS: PROPOSALS, PROBLEMS, AND ARGUMENTS

CHAPTER 1: MECHANISMS OF COMPENSATION

(Excerpted from: Compensation for victims of toxic pollution -- assesing the scientific knowledge base; a research report prepared for the National Science Foundation. Washington, National Science Foundation, 1983, 219 p.)

I. Tort Law

1. Theories of Action

Liability for property damages and personal injury from environmental contaminants has been based on a variety of legal theories of action. Common law negligence, forms of strict liability for dangerous consumer products and ultrahazardous activities, and breach of warranty have been the major causes of action argued in civil courts. Battery, fraud and false representation, and malpractice are less frequently used bases for civil suits. Because of the complexities of addressing differences in common law interpretations of these causes of action among the various jurisdictions, the analysis of this chapter is based on generic principals such as indicated by the Restatement of the Law of Torts (second)[4].

a. Negligence.

The common law of negligence provides a basis for compensation where loss or injury occurs as a result of the failure of a named defendant to exercise reasonable care. The plaintiff must prove four elements in a negligence case: first, that a duty, recognized by law, required the defendant to conform to a certain standard of care to protect others from unreasonably risk of harm; second, that the defendant's conduct did not conform to this standard of care; third, that there was a reasonable close causal connection between the defendant's conduct and the resulting injury; and finally, that actual injury or loss occurred.[1] Plaintiffs are no longer required to prove a formerly essential element in negligence theory called "privity of contract": that a direct relationship existed between the product manufacturer or the supplier of defective consumer products and the ultimate consumer.[2] Every jurisdiction recognizes that a manufacturer of a product owes a duty to the consumer regardless of any direct contact that the two may have had, and the manufacturer can be held liable for negligence for any injuries that result as a proximate cause of defects in the product.

In a negligence action, the burden of proof requires the plaintiff or victim to introduce sufficient evidence as to each essential element. This aspect of the burden of proof is called "the burden of production;" whether the plaintiff has met this burden is a question for the judge to decide. If the plaintiff fails to satisfy this burden, the judge may take the case away from the jury and direct a verdict for the defendant.[3]

Once the plaintiff withstands a motion for a directed verdict, the plaintiff must then introduce sufficient evidence to persuade the jury to reach a verdict in his or her* favor. This aspect of the burden of proof is called "the burden of persuasion." The jury decides whether the plaintiff has met this burden. In a negligence action, the burden of persuasion is met when the victim persuades the jury by a preponderance of the evidence that each essential element of the case occurred as the victim alleged.[4] If the plaintiff persuades the jury that the greater weight of the evidence supports the victim's allegations as to each essential element of the action, sufficient evidence has been offered to satisfy the preponderance of the evidence standard, and a verdict favoring the plaintiff should ensue. If the jury concludes that the defendant's evidence outweighs, or is equally as convincing as the plaintiff's evidence on any essential disputed issue of the case, the plaintiff has not satisfied the preponderance of the evidence standard, and a verdict for the defendant should result.

The first element to be proved, the standard of care to which the defendant owes a duty, may be established by various means. The court itself may adopt a statute or administrative regulation as the legal standard of care in certain negligence actions.[5] In some jurisdictions the courts have declared the unexcused violation of statutes or regulations to be conclusive evidence of negligence, i.e. negligence per se. In the absence of any standard of care imposed by statute or regulation, the jury decides the legal standard of due care to be applied in each case. Ultimately, the jury must weigh all of the factors and make its own determination of the reasonableness of the defendant's conduct.

One major factor in establishing a standard of care is the foreseeability of the risk posed by a defendant's conduct. A defendant is under no duty to guard against risks of injury unless he either knows or should know of the risks. Knowledge of a risk can be imputed to a defendant if such a risk was reasonably foreseeable.[6] All people are generally held to possess knowledge of such scientific information as is commonly available among laypersons and in the community.[7] Manufacturers are held to a higher standard of knowledge, that of an expert in the business in which the manufacturer is engaged.[8]

A manufacturer is under a duty to make a reasonably safe product for its anticipated use.[9] A manufacturer is not liable when the consumer has used the product in a manner for which it was not reasonably intended or forseeable.[10]

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*The phrase "his or her" will for convenience be abbreviated to "his" where gender is indifferent to the statement.

Most jurisdictions have held that a manufacturer of a product is liable for negligence in selling or manufacturing a product if the product could reasonably be expected to be capable of inflicting substantial harm if it is defective.[11] The plaintiff must also be able to show that the product was defective when it left the control of the defendant; the manufacturer is not liable for problems that arise a long time after the manufacture or the sale of the product.[12]

Even if the risk of injury is foreseeable, the jury may decide that the risk was reasonable. The defendant will then ordinarily not be liable for the damages or injuries resulting from the conduct that created the risk. Generally, a risk is considered to be unreasonable if it is of significant magnitude and probability to outweigh the utility of the conduct that presents the risk.[13] Some pharmaceutical products are inherently dangerous. Their risks are balanced by the benefits to patients for certain uses. Thus a chemotherapeutic agent is "safe" for the treatment of cancer, although its use causes nausea and failure of hearing. On the other hand, the same drug may not be safe for use in non-cancer patients when it causes the same effects. A defendant cannot be held negligent in failing to remove these dangers, although he can be held negligent in failing to warn of them.[14]

A product manufacturer may be negligent for the improper design, testing, or marketing of a product. Inadequate labels or warnings about the dangers inherent in the use of the product may provide an additional basis for compensation. An inadequate warning provides a particularly useful basis for compensation where the plaintiff's reaction to a product was an unusual allergic or idiosyncratic response. In these cases, the foreseeability and reasonableness of the risk associated with the product might not be sufficient to impose a duty on the manufacturer to alter the design of the product. The duty to label may be easier to impose. Adequate labels and warnings can often be placed on a product without destroying its utility, and they usually cost less than design changes. For this reason, many courts appear reluctant to dismiss negligence cases that are based on a theory of inadequate warnings, particularly when the disease or injury resulting from the product may be fatal and might have been avoided by an adequate warning.[15] Courts have sometimes found sufficient evidence to send a case to the jury on the issue of the adequacy of the warning even when the plaintiff's response to the product was highly unusual or the result of an allergic reaction.[16]

An additional factor in establishing a standard of care in a negligence action is the custom in the industry. Evidence that the defendant complied with the custom of the industry is relevant for establishing the reasonableness of the defendant's conduct, but the jury may hold the defendant negligent where an otherwise reasonable manufacturer might not have followed the custom. This may be true even where the custom is universally followed within the industry.[17] The courts readily acknowledge that what is reasonable in one course of commercial dealing may not be reasonable in another. Thus, where a particular segment of the manufacturing community holds itself out as having peculiar knowledge or expertise,[18] reasonableness is not judged by the standard of the entire community, but by the standard of care in the community of those that hold themselves out as having special knowledge.[19]

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c. Strict Liability for Abnormally Dangerous Activities.

Any person whose activities are abnormally dangerous to the community may be subject to strict liability for the injuries caused by the activity. This type of strict liability is also called "strict liability for ultrahazardous activities", "absolute liability", or "absolute nuisance". Liability may exist even though the defendant has exercised the utmost care to prevent harm.[34] The Restatement of Torts lists the following factors as considerations in establishing whether an activity is abnormally dangerous:

- The existence of a high degree of risk of some harm to the person, land, or chattels of others.
- The likelihood that the harm that results from it will be great.
- The inability to eliminate the risk by the exercise of reasonable care.
- The extent to which the activity is not a matter of common usage.
- The inappropriateness of the activity to the place where it is carried on.
- The extent to which the value to the community outweighs its dangerous attributes.[35]

Many courts have been reluctant to extend the doctrine of strict liability for abnormally dangerous activities to the manufacturers and sellers of the products that cause an activity to be abnormally dangerous.[36] In addition, evidence introduced to prove such a theory of recovery may undercut the victim's chances of recovery under other tort theories. This is because proof that an activity is abnormally dangerous requires the plaintiff to show that the risk inherent in the activity cannot be eliminated even with the defendant's utmost care. Such a showing may be inconsistent with the victim's argument that the manufacturer should be liable under a negligence or strict liability theory for improperly testing, designing, or labeling a product. In addition, certain products are unlikely to be considered abnormally dangerous when they are not regulated as toxic pollutants under any federal statute or regulation, are of common usage in the community, and are not under the control of the manufacturers when the potential harm occurs.

For these reasons, strict liability for abnormally dangerous activities will not be evaluated as a legal theory of recovery in the case studies. However, this theory of recovery may be of importance in cases where the user of an abnormally dangerous product provides a financially solvent defendant with "deep pockets" to provide for compensation.

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e. Other Causes of Action.

In addition to negligence, strict liability, and breach of warranty, plaintiffs can also bring suit charging battery, fraud, false representation, and malpractice.

In an action for battery, a plaintiff must prove that the defendant committed an intentional and offensive touching without plaintiff's consent.[67] Plaintiff need not be aware of the contact at the time it is made. The essence of the action is not the hostile intent of the defendant, but the fact that the plaintiff did not consent to it.[68] A battery is considered unpermitted if it would be offensive to the ordinary person not unduly sensitive.[69] Furthermore the plaintiff need allege no specific injuries.[70]

In an action for intentional misrepresentation, the plaintiff must allege 1) false representation of fact by the defendant, 2) defendant's knowledge or belief that the representation is false at the time it is made, 3) the defendant's intention to induce the plaintiff to act in reliance on the misrepresented fact, 4) the justifiable reliance by the plaintiff on the misrepresented fact, and 5) damages to the plaintiff as a result of misrepresentation. An action for negligent misrepresentation differs only in respect to the defendant's knowledge at the time of the misrepresentation to the plaintiff.[71] In the professional context, a manufacturer might be held liable for negligent misrepresentation if he could reasonably have been expected to know in light of the knowledge available to the professional community at the time, and failed to represent a material fact that, to his detriment, the plaintiff relied on.[72]

A finding of malpractice, or professional negligence, requires that the plaintiff show that the defendant failed to exercise the skill and learning commonly possessed by members of the profession in good standing.[73] A professional who follows a minority school of thought in his or her field will be judged for applying the standard of care by the tenets of the school he professes to follow.[74]

2. Selection of a Tribunal (Forum)

Each trial ordinarily includes two decision-makers: the trier of fact and the decider of questions of law. The judge always decides questions of law and, at the defendant's option, may also decide all questions of fact. The defendant has a right, however, to have all questions of fact decided by a jury.

The pivotal issue in choosing whether to file suit in a state or a federal court is the forum's jurisdiction over the defendant. One basis for suing in a federal court of a state is that the defendants reside or are incorporated there but the plaintiff resides in another state (diversity of citizenship).[75] The second basis is jurisdictional amount: requested damages must exceed $10,000.[76]

However, the practical aspects of suing foreign defendants in their home states are enormous. Plaintiffs have therefore sued on the basis of state long-arm statutes and in local federal courts, again on the basis of diversity and jurisdictional amount. Constitutional due process requires that plaintiff can sue only those parties who have minimal contacts within the state.[77] The Constitution is satisfied if the defendant does business or derives substantial income from activities within the state, owns property there, or causes tortious injury in the state by an act or omission inside the state or by a persistent course of conduct within the state.[78] Where plaintiffs have moved from the state in which plaintiff was exposed to injury, this requirement may mean that jurisdiction cannot be obtained over all possible manufacturers of a chemical.

Generally, state forums have been preferred over federal courts. The scope of discovery proceedings allowed by civil practice of the state and federal jurisdictions, the identification of a sympathetic judge, and the congestion of the respective court dockets are factors influencing the choice.

From some state trial courts, only one appeal is possible, to the state's highest court. In other states, for example, New York and California, an appeal must be taken first to an intermediate court and thence to the state's highest court. If the action is originally brought in federal district court, appeal is to the federal Court of Appeals. Only in rare circumstances would an appeal be heard in the United States Supreme Court.

3. Parties

Under the law of all states an individual who claims the status of plaintiff must be sufficiently aggrieved to allege facts forming the basis of a case or controversy.[79] This case and controversy requirement forms the basis of the plaintiff's standing to sue in a court. It generally means that the plaintiff must allege a controversy that is "definite and concrete touching the legal relations of parties having adverse legal interests."[80] Otherwise, the action will be dismissed for insufficiency of the pleadings.

Tort litigation is an adversarial process in which the injured party names as a defendant any party against whom he might be able to prove responsibility for his injury. Defendants in the usual tort action involving toxic substances will thus include the manufacturer of the toxic substance allegedly responsible for the claimed injury and those involved in its subsequent distribution. If the alledged exposure is occupational, the injured party's employer will be a defendant only if an action against him is not barred by the state's workers' compensation law.[81]

Normally, an injured party attempting to affix responsibility on a manufacturer of a defective product, including a toxic substance, must identify the particular manufacturer responsible for his injuries.[82] In toxic tort cases involving multiple polluters, however, this type of unique identification may not be possible as a practical matter.[83] In response to this dilemma confronting plaintiffs injured by toxic substances, some courts have recently displayed a willingness to allow the plaintiff to proceed against several manufacturers of the alleged toxicant without uniquely identifying the source of the product that actually caused the injury. In these jurisdictions, the plaintiff may recover against multiple polluters according to their market share in the chemical's production, provided he joins as defendants manufacturers who collectively represent a substantial majority of the market.[84]

A law review comment by Naomi Sheiner appeared in the 1978 Fordham Law Review,[85] carefully tracing the legal history of the use of joint and several liability for tortfeasors, where a specific party responsible for a tortious event could not be identified.

Under a theory of joint liability a defendant can be held jointly and severally liable for all damages to the plaintiff, although he may not have been responsible individually for the plaintiff's injury.[86] The defendant cannot compel the plaintiff to make other parties defendants to the action, and he cannot challenge the pleadings as insufficient on the grounds of nonjoinder.[87] Nor may he dispute the extent of his liability, although he may be entitled to contribution from his fellow tortfeasors.[88]

Three bases have been articulated for a finding of joint liability:[89] concert of action, alternative liability, and enterprise liability. The underpinning of each theory is that the defendants can each be said to be in control of the risk that resulted in injury to the plaintiff.

The theory of concerted action has been applied to group drag racing injuring a bystander.[90] It is based theoretically on the notion that the tortious act of one is the act of all and hence the actor is vicariously liable for all the actions of the other actors. Concerted action has been shown in cases by 1) evidence of explicit agreements between defendants,[91] 2) by evidence of parallel behavior sufficient to support an inference of tacit agreement or cooperation,[92] and 3) by evidence of independent adherence to an industry-wide standard.[93] Dean Prosser has described the rationale for the imposition of this theory of liability by stating:

> those who, in pursuance of a common plan or design to commit a tortious act, actively take part in it, or further it by cooperation or request, or who lend aid or encouragement to the wrongdoer, or ratify and adopt his acts done for their benefit, are equally liable with him.[94]

Class Actions.

A class action lawsuit can provide a powerful tool for redressing grievances. By joining a group of plaintiffs who have suffered similar legal wrongs, it is possible to proceed with litigation that otherwise may not be economically justifiable. In turn, this encourages that the social costs arising out of the defendant's activities be borne by the defendant. Finally, class actions promote judicial efficiency, since they reduce the need for multiple lawsuits.[95]

Rule 23 of the Federal Rules of Civil Procedure is the primary legal standard concerning class actions. It governs all class actions in the federal courts,[96] although a number of jurisdictions also have class action rules for use in the state courts.

Under Rule 23(a) the four prerequisites for class action certification are: (1) numerosity; (2) common questions of law and fact; (3) typicality of the claim; and (4) adequacy of representation. In addition to these requirements, the court must determine whether any one of four additional criteria under Rule 23(b)[97] apply to the litigation. If they do, the court may certify the case as a class action suit.

In products liability litigation, the most commonly applied of the four criteria is specified under Rule 23(b)(3). This requires the party seeking certification to show that class questions predominate over questions affecting individual members and that, based on the four listed factors, a class action is superior to other methods of adjudicating the controversy.[98]

Historically, class actions involving chemical products liability have not been generally successful, partly because of differences in the times, circumstances, and places of the injuries.[99]

However, one federal district court judge in Massachusetts recently granted conditional class certification to twenty-seven women exposed to DES _in utero_.[100] The judge limited the class to women with adenosis who resided in the state all their lives. This, along with the development of legal theories for bringing such actions, suggests that class actions may become increasingly important in the redress of injuries caused by chemical hazards and other forms of environmental pollution.

4. Evidentiary showing

The injured party has the burden of showing, by a preponderance of the evidence, that the defendant failed to exercise the applicable legal standard of care,[101] that this breach of duty caused the injury, and that injuries to persons in situations similar to the plaintiff's were a reasonably foreseeable consequence of the breach of duty.[102] In most toxic substance litigation, the second element of this showing--the proof of causation or of "proximate cause"--is likely to be the plaintiff's highest hurdle.[103]

a. Proof of Causation

The plaintiff must show that, from among all possible causes of his injury, the defendant's conduct was more likely than not a substantial factor in bringing about the injury. A plaintiff who seeks to prove that his lung cancer was caused by a particular exposure to a toxic substance confronts a major difficulty if he is also a heavy smoker of cigarettes. The difficulty is heightened if the court adopts a "one-hit" theory of cancer causation.[104]

In order to establish causation, the plaintiff must identify the injury-causing substance, must trace its path from the defendant to the plaintiff, and must show that it is responsible for the plaintiff's disease.[105] Thus, the plaintiff would probably not prevail if he could show only that (1) one or more hazardous substances existed at sites adjacent to his residence, (2) one or more modes of transport existed through which the substances could have reached him, and (3) in persons similarly situated to the plaintiff, the identified hazardous substances are merely suspected of giving rise to the sort of injury the plaintiff suffered. Nor would a plaintiff be likely to recover if the only evidence he offered in establishing a causal connection was that he was exposed to a chemical spray and that he woke up the next morning suffering from an undiagnosed physical impairment.[106] Such a plaintiff would also have to adduce information concerning the characteristics of the chemical substance to which he was exposed and the effects that such chemicals might have on individuals exposed in similar fashion.

On the other hand, causation could well be established in a tort action if, for example, the plaintiff provided proof of the presence of toxic chemicals, a plausible route of exposure, and expert testimony as to the cause of the injury.[107] Moreover, the elements in the causal chain need not each be proved directly, but may be proved by circumstantial evidence.[108] It is not necessary for the plaintiff to establish conclusive evidence of causation. As with the other essential elements of a tort action, proof of causation may be by a preponderance of the evidence.

Substantial disagreement exists in the legal community over the proper approach to the issue of causation.[109] In cases involving pollution-induced illnesses, the issue of causation will, at a minimum, encompass problems of both scientific proof and legal policy.

Prosser suggests that proximate cause involves a number of distinct and substantially unrelated problems:[110]

- The problem of actual cause or causation in fact. Actual cause requires a factual finding and is therefore a question for the jury. Many courts have used the "but for" or "sine qua non" rule in determining actual cause. This rule asks whether the plaintiff's injury would not have occurred "but for" the alleged tortious conduct of the defendant. The "substantial factor" test has been generally accepted as an alternative test of causation. This test is particularly suitable for cases where two or more forces cause the injury. Courts utilizing the substantial factor test ask whether the defendant's conduct was a material element and substantial factor in bringing about the injury.[111]

- The problem of unforeseeable consequences. This problem is one of legal policy, not actual cause. If the plaintiff's injury is found to be outside the scope of the foreseeable risks posed by the defendant's conduct, the conduct is not the legal cause of the injury.[112]

- The problem of intervening causes. An intervening force may break the chain of legal causation if the intervening force was unforeseeable. Once the legal chain of causation has been broken, the intervening force becomes the superseding cause of the plaintiff's injuries. Intervening forces which are foreseeable generally do not tend to relieve the defendant of liability.[113]

- The problem of shifting responsibilities. This problem arises when the defendant relies on another person to take reasonable precautions to protect the plaintiff.

- The problem of apportionment of damages among multiple causes.

There are two major reasons that a plaintiff's ability to prove causation decreases substantially as the length of time between exposure and the onset of injury increases. First, courts are accustomed to dealing with personal injury cases involving easily observable physical traumas and equally clear physical consequences; they tend to let the jury give undue evidentiary weight to an immediately preceding alleged cause.[114] In the past few decades this tendency of the courts led to a large number of recoveries in tort for "traumatic cancer"--cancer allegedly caused by a single physical blow to the body--despite overwhelming medical testimony to the effect that physical traumata are not a very likely cause of cancer. Conversely, juries relying on common sense are likely to require rather persuasive expert evidence of causation where the interval between the alleged cause and the onset of the disease or injury is relatively great. Indeed, although a "preponderance of the evidence" standard usually governs in a tort action, juries dealing with cases of latent injury may be tempted to require something closer to a scientific standard of proof from medical experts testifying on behalf of the plaintiff.

The second reason is that the passage of time--perhaps as much as twenty years or more in the case of cancer--renders the evidence as to the nature, intensity, and route of exposure difficult for the plaintiff to recover. Indeed, the injured party himself may not make the connection between a long-ago exposure, even if he was aware of it at the time, and his current state of health. The passage of years also makes it difficult to obtain relevant documents and witnesses whose memory of the events is adequate.

The plaintiff must produce all data and other information necessary to prove each element of his case by a preponderance of the evidence. In cases involving toxic substances injuries, this is likely to require that expert medical witnesses testify as to the plaintiff's injuries, that toxicologists and other scientists testify as to etiology,[115] that epidemiologists conduct studies and testify as to causation (especially where exposure to large numbers of persons is involved),[116] and that industry experts testify as to the applicable standard of care. Such testimony is clearly very expensive and time-consuming to produce. Should epidemiological evidence be required, the cost of preparing a study, especially one that is well-designed and rigorously controlled, is likely to be beyond the means of any individual plaintiff.[117]

In toxic substances litigation the plaintiff is likely to encounter a series of obstacles in getting some of his most probative evidence admitted in court. To the extent that epidemiological evidence relies on statements made by those surveyed, it may be excluded under the hearsay rule.[118] Small-scale epidemiological studies may also be excluded at the discretion of the judge on the grounds that such studies are unduly confusing, prejudicial, or a waste of time.[119] Nonetheless, epidemiological evidence was admitted in at least one old case, on the grounds that

> even with regard to each individual case evidence tending to show that the individual was but one of a large number of persons similarly affected would be competent for the purpose of showing that each individual affection was traceable to a common source.[120]

Evidence of out-of-court animal tests, often a crucial part of the case for a toxic substances victim, may be excluded as simply irrelevant.[121]

In an action based on improper product labeling or inadequate product warning, the courts are split on whether the plaintiff must prove that the injury would not have occurred if the buyer had been warned of the defect. Some courts will dismiss a case if the evidence does not support an inference that the buyer, if warned of the risk of a product, could have purchased another product or none at all.[122] Many courts create a rebuttable presumption that an adequate warning would have been read and followed.[123]

After establishing the defendant's responsibility for his injuries, the plaintiff must also produce evidence concerning the extent of his injuries and of the compensation required to make him whole. The defendant may present whatever evidence he chooses to rebut the plaintiff's case. Unlike the plaintiff, however, the defendant need not as a matter of law produce evidence in order to win on any given point at issue.

b. Statutes of Limitation

A civil action must be filed within the period of time prescribed by the applicable statute of limitations of the jurisdiction in which the suit is filed. Failure to file a timely action will result in the dismissal of the suit on the basis that it is time-barred.

Most states have general statutes of limitations for personal injuries. They require a claim to be filed within two or three years of the accrual of a cause of action, regardless of the theory of liability which the plaintiff pleads. In addition to these general prescriptive periods, many states now have specially prescribed limitation periods for claims arising out of defects in products. These latter statutory periods are probably better described as statutes of repose, since their purpose is to protect commercial activities after "memories have faded and evidence disappeared." Product liability statutes of limitation generally run from the time that the product leaves the control of the manufacturer or is sold to the buyer in whose possession it causes an injury.

In most jurisdictions, legislation defines the time at which the cause of action begins to accrue, for the purpose of computing the time in which a claim must be filed. Substantial judicial modifications of statutory language have liberalized many restrictive provisions. General personal injury statutes of limitation run from three points of time: 1) the time that the injury was inflicted; 2) the time at which the injury or its symptoms become manifest; and, 3) the time at which the injury and its relation to the defendant's conduct are discovered or could have reasonably been known by the plaintiff.

Different jurisdictions adhere to different rules for determining when the statutory period begins. Some states have adopted the "discovery rule" for determining the time of injury in medical malpractice suits where the injury may remain latent for a long period of time. Under the "discovery rule," the statute of limitation does not begin to run until the patient learns, or in the exercise of reasonable care should have learned, of the injury.[124] However, in jurisdictions that have not adopted the discovery rule or extended its applicability beyond medical malpractice cases, the statute of limitations may pose a major obstacle to compensation.

Product liability limitation periods, particularly in jurisdictions that have adopted "discovery" statutes of limitations, may have the unexpected result of disallowing a claim. This is because they may limit the plaintiff's ability to recover by not permitting any consideration of the relation of the product to the plaintiff's injury. These statutes by their very nature are also less amenable to judicial manipulation because the point at which the injury accrues is defined more clearly by points in the product's history rather than by amorphous terms such as "injury."[125]

Another type of statutory prescriptive period may affect the outcome of chemically-related injuries when claimants aver fraud and misrepresentation. Most state statutes contain tolling provisions, in the event of fraud or misrepresentation by defendants. If it were possible to prove the truth of an allegation that the manufacturers knew of or had constructive knowledge of the harmful effects of their product these tolling provisions might apply in favor of admitting a claim. Generally, however, such tolling provisions apply only where there is evidence of actual fraud on the part of the defendants.

c. Contributory Negligence/Assumption of Risks

A plaintiff who voluntarily and knowingly assumes a risk of some known hazard may provide the defendant with a defense to liability in a strict liability or negligence case in some states.[126] This defense is not available to a defendant when the plaintiff was not aware of the particular risk.

5. Recovery of Damages

Under the common law the plaintiff in a successful case can recover all damages proximately caused by the defendant's acts.

Possible recovery in most jurisdictions includes damages for pain and suffering, reasonable expenses for medical care, necessary psychological counseling, and social, physical and vocational rehabilitation, legal costs, loss of earnings prior to trial, loss of future earnings because of reduced capacity, and mental anguish if accompanied by physical injury, including anguish caused by the reasonable apprehension of future disability.[127] Juries may also award punitive damages, where a defendant is found guilty of wanton and reckless behavior which has resulted in the plaintiff's injuries. The plaintiff must adduce evidence as to medical expenses incurred and likely to be incurred, lost past and future wages, and pain and suffering. This phase of the plaintiff's case may require him to produce, at his own expense, expert vocational, medical, economic, or actuarial testimony.

For the purpose of awarding damages, the plaintiff's injuries are fixed as of the time of litigation. If additional injuries subsequently become apparent, the plaintiff is precluded from relitigating his case on these grounds. Future injuries not yet manifested are compensable in a tort action only to the extent that they are reasonably certain to appear.[128] Thus, a plaintiff will rarely recover damages for an enhanced probability of cancer in the future. In one case, however, the court did award damages for future cancer arising from an X-ray burn on the basis of expert testimony that such cancer was reasonably certain to follow this exposure to radiation.[129]

The likelihood of recovery for toxic substance injuries is generally quite difficult to state. Relatively few such cases have been tried to final judgment. Of more than 50 suits filed and studied in a recent survey,[130] only one (involving out-of-pocket economic injuries to a stable owner from dioxin-contaminated oil sprayed around the stables) resulted in a final judgment for damages. The remaining cases of those surveyed are either not yet settled or else the parties reached a settlement before the completion of litigation. The dioxin case represented a relatively easy case for recovery because it involved

> a discrete exposure to an identifiable hazard. The damages and routes of exposure were well documented and the incident was fairly local in nature. In addition, the number of potentially culpable parties was small.[131]

The stable owners received nearly full compensation for their out-of-pocket losses. [132]

Perhaps a more representative case involved lead poisoning of area residents from a lead smelter.[133] Of the suits so far terminated, all were settled before trial. Thirty-three suits were filed alleging health damages, mental anguish, and lead-induced medical symptoms.[134] The 117 plaintiffs with private attorneys received an average of $3,950; and 89 plaintiffs in "friendly suits" using guardians ad litem received an average of $1,327 each in court-awarded settlements.[135] Hospitalized children with the highest blood levels of lead in one typical suit recovered the highest compensation. One of these children received $19,000 and the other received $10,000.[136] Some medical expenses were uncompensated and others were borne by the individual families.[137]

Somewhat more precise information on the likelihood and amount of recovery in personal injury tort litigation is available from the numerous studies of compensation in automobile crash litigation.[138] Several general features of the tort compensation system are apparent from these studies. First, not all seriously injured victims received compensation. One study shows that only 37 percent of those suffering economic loss from a personal injury resulting from an automobile accident received any damages in a tort action.[139] Among those "seriously injured," only 55 percent received anything from a tort claim. Second, victims with relatively slight injuries are paid quickly and in amounts many times greater than their losses.[140] Presumably this reflects the pressure of the nuisance value of such suits. Third, those with serious injuries tend to be undercompensated and then usually only after long delay. These drawbacks of the tort compensation system are likely to be heightened in the context of toxic substance injury litigation, where proving causation presents far more complex problems for plaintiffs.

6. Financing

Any recovery in a tort suit is paid out of the defendant's pocket. Corporations that handle or manufacture toxic substances may be able to obtain insurance for some injuries resulting from their activities. But in most cases, this coverage is limited by a restrictive endorsement in the liability insurance contract which limits liability to cases of sudden or accidental discharges,[141] and does not cover injuries resulting from instances of continuing pollution. Products liability insurance contracts are also likely to provide only limited coverage for injuries resulting from toxic substances. These contracts generally do not extend coverage for intentional or reckless conduct. "Coverage is available, however, for toxic substances which generate liability due to a defect in the product or due to an improper or incomplete warning."[142]

The recent enactment of the "Superfund" legislation, the Comprehensive Environmental Response, Compensation, and Liability Act, P.L. 98-510, imposes new obligations on manufacturers of toxic substances to obtain insurance coverage. The legislation does not, however, apply to personal injuries resulting from exposure to toxic substance pollution.

The courts also have the authority to create a trust, using the damages won by plaintiffs for their having been exposed to environmental pollutants. This has been done with respect to damages awarded against Allied Chemical for the injuries to

Virginians from kepone, a product manufactured by their subsidiary, Life Sciences, which found its way into the James River. This power has been used conservatively, and the Virginia Environmental Endowment is an outstanding example of its innovative potential.

Availability of Liability Insurance

Product liability insurance is available to indemnify defendants for their losses in pollution or chemical injury cases. However, rates for this type of insurance are astronomically high, and thus many smaller manufacturers may not have insurance. In the event that these defendants are found to be judgment proof upon the rendering of a verdict or judgment against them, plaintiffs may be left without recoveries. All the larger pharmaceutical houses have product liability indemnity insurance available to them. It is possible that the availability of insurance may provide a disincentive to test products thoroughly for all their hazardous effects.

(How three compensation systems work. Excerpted from: Compensation for victims of toxic pollution -- assessing the scientific knowledge base; a research report prepared for the National Science Foundation. Washington, National Science Foundation, 1983. 219 p.)

IV. Social Security Disability Insurance (SSDI)

1. Forum

The social security disability insurance system involves both administrative and judicial forums. The first four adjudicatory steps are administrative; the last step is judicial review. Alone among social security insurance programs, disability adjudication involves a joint state-federal process.

As the first step, the Social Security Administration (SSA) accepts claims for disability benefits at its federal district offices.[168] The district offices forward the claims to the state agencies,[169] which both develop evidence and determine disability on the documentary record.[170] The state agencies send their determinations to the Office of Disability Operations (ODO) at SSA headquarters.[171] The determinations made by the states are issued by ODO as federal decisions.[172]

A dissatisfied claimant moves up the adjudicatory ladder by requesting reconsideration of the federal decision.[173] The reconsideration decision retraces the original route: the federal district office receives the claim, the state agency again develops evidence and reconsiders its determination,[174] and SSA issues a federal decision.[175] SSA can reduce the amount of state awards, remand a determination to the state agency, or otherwise modify the decision.[176] Such SSA modification or remands of state decisions are uncommon.[177]

A claimant dissatisfied with the reconsideration of a claim may request a formal hearing before an administrative law judge (ALJ) in one of the local hearing offices of SSA's Office of Hearing and Appeals (OHA).[178] The hearing before the ALJ is the claimant's first opportunity to present the case in person.[179]

The dissatisfied claimant's final administrative step is an appeal to the Appeals Council at OHA headquarters.[180] The Appeals Council may refuse to hear an appeal.[181] It may also review an ALJ decision on its own motion. At no stage of the administrative process may the federal government appeal an adverse decision.[182]

The final potential forum in the disability claims procedure is an appeal of the administrative decision to federal district court.[183] Cases remanded by the courts to SSA, if reheard, are usually heard by an ALJ other than the one who originally heard the claim.[184]

2. Parties and Participants

The Secretary of the Department of Health and Human Services (represented by the Social Security Administration) and the claimant are parties to the social security disability adjudication process.[185] Additional parties permitted at the hearing include any persons who were parties to any prior determination or reconsideration of the same claim, those who make claim on the disabled worker's earnings record, and certain other parties whose rights may be affected.[186] An employee of the SSA, appointed by the Director of the Bureau of Hearings and Appeals, presides.[187] Neither former employers of the claimant, nor any person allegedly responsible for the claimant's disability, is a party to the hearing, for no liability to them is at issue. The claimant has a right to representation at the hearing by an attorney or a layperson, or the claimant may appear alone.[188]

3. Evidentiary Showing

a. Claimant

In order to receive disability benefits, a claimant must show that he has achieved insured status,[189] met certain other preconditions,[190] and is unable

> to engage in any substantial gainful activity by reason of any medically determinable physical or mental impairment which can be expected to result in death or which lasted or can be expected to last for a continuous period of not less than 12 months....
>
> [A person shall be] determined to be under a disability only if his physical or mental impairment or impairments are of such severity that he is not only unable to do his previous work but cannot, considering his age, education, and work experience, engage in any other kind of substantial gainful work which exists in the national economy....[191])

By regulation, a worker is disabled if, in the absence of evidence to the contrary, he suffers from one of many impairments or their medical equivalents, as listed by SSA.[192] Should the claimant not meet this standard, he nonetheless qualifies for disability benefits if his condition prevents him from engaging in any "substantial gainful activity." This last determination--the so-called "residual functional capacity" criterion--is based on such factors as age, education, and work experience.[194] This is a difficult criterion to apply consistently and has apparently caused much controversy. The following examples are illustrative:

> [A]n individual who retains the the physical ability to do a wide range of light work, who is not of advanced age, and is able to communicate, read and write on an elementary level, would generally be considered to still be in the competitive labor market for light, unskilled work, despite the absence of special experience or skills.[195]

On the other hand, an individual restricted to light work as a result of severe medically determinable impairment, aged 50-54, illiterate or unable to communicate in English, with prior unskilled work experience only, is "disabled" and will receive benefits.[196]

In 1979, the "residual functional capacity" criterion accounted for 23.9 percent of all disability claims initially allowed.[197] At each successive stage of the adjudication process, the decision-making focuses increasingly on the criterion, and it eventually accounts for about half of all claims allowed.[198]

b. Administrative Law Judge

The ALJ presides over the hearing and has an affirmative duty to ensure that evidence is adduced in four categories: medical data and findings (for example, X-rays, results of physical examinations, medical histories), expert medical opinions (conclusions as to degree of pain, exertional limits imposed by the impairment, ability to work, etc), subjective complaints, and the claimant's age, educational background, and work history.[199] The ALJ has an affirmative duty to seek out any ascertainable facts that would entitle the claimant to relief, notwithstanding the claimant's failure to do so on his own initiative.[200] The presence of counsel for the claimant does not relieve the ALJ of this duty.[201] Courts are especially quick to enforce this duty when the claimant is obviously unable to press his own claim effectively. At the request of a party or on his own motion, the ALJ may subpoena witnesses, books, records and other documents.[202] The ALJ may examine any witnesses.[203]

Although one court has implicitly endorsed the use of a medical treatise by the ALJ to support a finding of disability,[204] the majority rule seems to be that such resort to treatises is not permitted where they were not the subject of expert testimony.

c. Department of Health and Human Services (HHS)

The HHS representative can present witnesses and evidence with the leave of the ALJ.[205] Because of the affirmative duty of the ALJ to assist the claimant, however, the social security disability process is relatively non-adversarial in character.

d. Procedure

Either party may request the presiding officer to subpoena witnesses. The presiding officer may grant the subpoena if he determines that the witness is "reasonably necessary for the full presentation of [the] case."[206] Witnesses testify under oath and may be examined by the ALJ or either party.[207]

Conflicting medical evidence is "not common" in social security disability hearings.[208] The presiding officer may receive evidence at the hearing "even though unadmissible under rules of evidence applicable to court procedure," subject to an exception for earnings records.[209] In particular, unsworn written statements by physicians who have examined the claimant are admissible despite their hearsay character,[210] as is other hearsay evidence. Such evidence

> despite the presence of opposing direct medical testimony and testimony by the claimant himself, may constitute substantial evidence supportive of a finding by the hearing examiner adverse to the claimant, when the claimant has not exercised his right to subpoena the reporting physician and thereby provide himself with the opportunity for cross-examination of the physician.[211]

Generally speaking, evidence is admissible at the hearing if it is probative and relevant.[212]

The procedure generally followed at the hearing, including the order of presentation of evidence and allegations, is at the discretion of the ALJ, provided that the ALJ affords the parties "a reasonable opportunity for a fair hearing." The hearing is open to the parties and any other persons the ALJ deems appropriate. The ALJ must afford the claimant a reasonable time for oral argument. The claimant has the burden of proof to show his impairment, but the ALJ is obliged to assist him in making this showing, to the point of ordering medical examinations and summoning medical witnesses. The claimant must meet a standard of "substantial evidence" and some commentators have interpreted this as a standard shaded in favor of the claimant.[214]

4. Recovery of Damages

Roughly speaking, a claimant may recover for any total medical disability that prevents him from engaging in substantial gainful activity for twelve months or more.[215] There is no statute of limitations or other time bar on recovery, although back recovery may not be had for more than twelve months preceding the date of the claim.[216] The range of ailments for which recovery is routinely allowed is great, and compensable disabilities include many respiratory,[217] cardiovascular,[218] and mental disorders,[219] as well as alcoholism,[220] cancer,[221] arthritis,[222] and more vague disabilities.[223]

So long as he is disabled, the worker-claimant may recover an amount based on previous earnings and intended to replace those earnings. The claimant's spouse and minor children receive an additional benefit proportional to the worker's benefits. A worker eligible for SSDI benefits is also automatically eligible for Medicare. The average SSDI recipient in 1978 recovered a medical payment of $1,100, which accounted for 43 percent of his medical expenses.

The SSDI program provided monthly benefits, averaging $320, to 2.9 million disabled workers in 1979.[224] The average total benefit paid in 1978 was $30,000.[225] Two million dependent spouses of the disabled workers,[226] including spouses over age 62,[227] spouses caring for minor and disabled children,[228] children disabled in childhood, children under age 18, and children who are full-time students between ages 18 and 22,[229] also received benefits. The average monthly benefits to a disabled worker's family were $639 in 1979.[230] The 1979 maximum monthly benefit to a disabled worker was $552; to his family, $967.

The average disabled worker tends to have other sources of income in significant amounts.[231] A disabled worker will not receive SSDI benefits if his other earnings exceed $300 per month ($3,600 per year).[232] Very few disabled workers' families have more than a ten percent reduction in disposable income as a result of disability.[233]

The SSDI benefits a worker receives are based on the worker's past income, indexed for inflation, for those years the workers could reasonably be expected to have been in the workforce.[234] The years to be averaged are those from age 21 to the year before the onset of disability, with the two years of lowest earnings omitted.[235] Benefits are adjusted annually for increases in the Consumer Price Index.[236]

Several procedures are used to determine whether a beneficiary has recovered medically and/or is able to return to work. First, newly entitled beneficiaries whose conditions are most likely to improve are scheduled for reexamination, usually within 18 months. Second, if the beneficiary voluntarily reports earnings (as applicants are asked to do), or if SSA learns of earnings through its system of checking earnings in covered employment, the case is evaluated to determine whether the beneficiary is engaging in substantial gainful employment. Third, the state agencies monitor the beneficiaries' medical condition through periodic questionnaires by telephone or mail and by soliciting information regarding the recipient's present medical condition from sources of past treatment.[237]

In 1979, 38 percent of the 1,250,000 SSDI claims brought were allowed initially. More than 28 percent of the claimants initially denied sought reconsideration; 28 percent of these were then allowed.[238] Of the reconsiderations, 58 percent sought a hearing and the ALJs and Appeals Council allowed 48 percent of these.[239] Approximately 12 percent of the claimants who lost at the hearing level sought judicial review, nearly half of the claims were remanded, and 22 percent of the claimants eventually succeeded. Overall in 1979, claims initially allowed represented 82 percent of all claims ultimately allowed.[240]

5. Financing

Covered workers[241] and their employers[242] contribute equally to the Social Security Disability Trust Fund, from which payments are made. Total contributions are currently 10.16 percent of an employee's covered wages,[243] including taxes for old age and survivor's insurance, with no wages covered beyond $25,000 per year.[244] The payments to the Fund are based on aggregate actuarial considerations only, not on the historical incidence of claims by a particular employee or on resultant actions taken by the particular employer-contributor.

V. Worker's Compensation

Workers' compensation is a remedial system established under state law. Its precise organization varies from state to state. What follows is a necessarily oversimplified account of issues that might arise in any jurisdiction when an employee seeks workers' compensation benefits for a toxic substance injury.

1. Forum

The administrative structure of workers' compensation differs from one jurisdiction to another. Generally, administration is entrusted to an agency headed either by a single administrator or by a board or commission.[245] Although procedures followed in workers' compensation cases vary widely, the administrative process usually includes a number of steps (initial reports, informal conferences, pretrial procedures) leading up to a formal hearing in contested cases.[246] In large jurisdictions, formal hearings are held in regional centers, often located in the county of the worker's residence or employment.[247] The hearing officer's decision is never final.[248] The dissatisfied claimant may resort to an administrative review procedure or directly to the courts on appeal, as provided by state law.

The final step in a disputed workers' compensation proceeding is judicial review. Most states limit the scope of review by stipulating that administrative findings of fact shall be conclusive if supported by substantial evidence.[249] Some state courts, however, are empowered to conduct de novo trials.

2. Parties

There is no state in which workers' compensation laws cover all forms of employment. In some states, compulsory coverage is still restricted to hazardous occupations.[250] The covered worker claiming compensation for occupational disease or injury is one of the parties to the claims process. The other is the employer and/or, in private insurance jurisdictions, the employer's insurance carrier. Despite the relatively non-adversarial character of the workers' compensation system, disputes between these parties are likely to arise in cases involving toxic substance injuries. Generally, disagreements may be expected on the issue of compensability (whether the condition is employment-related) and on the extent of disability.

3. Evidentiary Showing

At its inception, compensation to workers was a response to industrial accidents, not to occupational disease. Many state workers' compensation statutes still retain traces of this historical orientation, especially in provisions relating to the employee's qualification for compensation. Thus, in most states, employees seeking compensation must show personal injury or disease incurred "by accident" an arising "out of and in the course of employment."[251] A large number of states exclude compensation for "ordinary diseases of life" or diseases to which the general public is equally exposed.[252] These eligibility requirements frequently pose severe evidentiary problems for workers suffering from a suspected occupational disease.

The claimant in a proceeding has the burden of proving that his disease was causally related to his employment.[253] Ordinarily, medical testimony is required on the issue of causation,[254] although some jurisdictions have permitted a "natural inference from human experience" to substitute for expert testimony under narrowly circumscribed conditions.[255] Jurisdictions differ as to whether the claimant may choose his own physician or must use one provided by his employer. Some states have established special medical boards or panels of experts to examine the claimant and to render an unbiased opinion in cases of occupational diseases.[256]

To satisfy the trier of fact by a preponderance of the evidence, the claimant must show something more than a mere medical "possibility" that his condition arose out of employment.[257] But expert evidence of a medical possibility, taken together with supporting non-expert evidence, may support the requisite inference of a medical probability.[258] In the case of toxic substance-related disease, the claimant may not need to produce details concerning the exact amounts, types, and toxicity of substances he has been exposed to.[259] At least one court has suggested that the burden should properly fall on the employer to come forward with any such detailed information in his possession.[260]

On the issue of multiple causation, a number of jurisdictions endorse the view that the claimant's employment need only be a "contributing cause" (not the sole or proximate cause) of the disease or injury.[261] Generally, evidence in a workers' compensation proceeding should be liberally construed in favor of the claimant.[262]

4. Recovery of Damages

Depending on the jurisdiction, an employee seeking compensation for a condition potentially related to toxic workplace exposure is likely to encounter one or more barriers to recovery. Many states, for example, have statutes of limitations prohibiting claims unless the disability or death occurs within a specified period of time following the last exposure to the alleged toxicant.[263] Some states also specify that exposure to the toxic substance must have occurred over a length of time, often five or ten years.[264]

In general, cash benefits are provided for temporary and permanent total disability, permanent partial disability, and death. Benefits are provided only for injuries resulting in wage loss. Impairments that do not affect the employee's capacity to work, such as sterility or loss of taste and smell, are thus not compensated.[265] Most cases of recovery for occupational disease involve short-term or minor conditions, such as dermatitis.[266]

Workers' compensation programs often impose fairly low ceilings on recovery. Over two-thirds of the states replace less than 40 percent of earnings lost as a result of permanent workplace injuries.[267] In some states, payment of benefits commences only when an agreement is reached on the claim.[268]

Overall, some two-thirds of claims alleging occupational disease are contested by the employer. Controverted claims can produce lengthy delays for the injured claimant: a recent sampling of successful occupational disease claims showed that the average delay from the date of filing to the first payment of benefits was 390 days, as opposed to 43 days for typical accidental injury claims.[269] Compensation is provided annually in some 30,000 occupational disease cases, representing only one-thirteenth of the estimated number of occupational illnesses.[27

5. Financing

Under state law, employers must demonstrate their financial ability to pay workers' compensation benefits. Most states permit employers to meet this requirement by purchasing insurance from private carriers. Some states have publicly operated insurance programs competing with private insurers.

VI. Collective Liability System

1. Theory of Action

A system of collective liability is a useful approach to compensation where the activities of members of a group may cause harm but it is sometimes difficult or impossible to determine which particular members are responsible for that harm. Where a culpable party cannot actually or practicably be determined, the damages are apportioned equitably among the group members. A number of federal environmental compensation mechanisms rely on this basic approach: the Black Lung Benefits Reform Act, the Deepwater Port Act (DPA), the Trans-Alaska Pipeline Authorization Act (TAPAA), the Outer Continental Shelf Lands Act (OCSLA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, otherwise known as "Superfund"). In addition, these laws impose liability without regard to fault on those parties causing statutorily defined harms.

The imposition of joint and several liability on defendants who are reasonably likely to have caused or significantly contributed to the injuries suffered is supported in both case and statutory law.[271] Similarly, liability without regard to fault (sometimes called "strict" liability) has been imposed on defendants in the contexts of (1) "abnormally dangerous activities"[272], (2) products liability[273], (3) activities under various federal environmental statutes[274], and (4) activities under various state environmental laws[275].

The courts have invoked a variety of policy reasons to justify strict liability: (1) the defendant may be in a better position than the plaintiff to control the risk; (2) the defendant may be able to pass the control costs on to the public;

(3) the defendant may [illegible] caused injury by engaging in an activity that benefits h[illegible] Although the specific defenses and elements of proof associa[illegible] with the various forms of strict liability may modify or qualify their impact, viewed as a whole they support the imposition of liability without fault in appropriate circumstances. While considerations of public policy inevitably will determine whether strict liability is warranted in the case of pollution-related injuries, the traditional justifications for such liability arguably support its imposition.

2. Forum

Administration of the system should involve existing agencies and organizations, wherever feasible. While it is not clear how the staff would be composed, they would have more expertise in scientific and medical matters than the average member of a jury or judge. Their expert scientific knowledge will also help them identify the party responsible for the claimant's injuries. Tasks required in the administration of the system include: (1) setting fund contributions; (2) evaluating and paying claims; (3) evaluating requests for reimbursement of reasonable court costs; (4) suing culpable manufacturers following payment of claims.

3. Parties

A person who believes he or she has suffered pollution-induced injury may either file a claim against the fund, or may proceed in court against the party or parties believed to be responsible for the injuries.

To recover from the fund, the claimant merely must prove that harm has resulted from exposure to the chemical or pollutant. A rebuttable presumption of causation assists the claimant in making this showing.

To recover directly from a specific manufacturer or manufacturers (as opposed to filing a claim against the fund) the injured party must prove in court that he has suffered harm from exposure to the chemical or pollutant and that the particular manufacturer(s) were reasonably likely to have caused or contributed significantly to that harm. Two rebuttable presumptions of causation exist to assist victims making these showings.

A manufacturer who is sued under this provision and provides compensation to the plaintiff is entitled to maintain an action for contribution against other manufacturers. In such an action, the courts may consider a variety of factors in apportioning the damages, including the degree of involvement in the harmful activity, and the ability of the litigants to distinguish their contributions to the plaintiff's injuries.

An action for contribution may also be instituted against a non-manufacturer (e.g., a doctor or pharmacist) based on traditional common law principles.[276]

4. Evidentiary Showing

Causation is perhaps the most difficult element to prove in litigation involving toxic substances-related injuries. In order to recover damages, tort law requires the injured party to prove that a particular defendant was the cause in fact of injury.* Establishing cause in fact with respect to toxic substances injuries essentially requires two elements of proof. First, the injured party must prove that a particular substance or hazard caused the injury. Second, the injured party must demonstrate that a particular party was responsible for creating that hazard.[277]

In cases involving claims against the fund, the collective liability system contains a provision that states:

> If the claimant introduces evidence sufficient to show that (1) the claimant was exposed to a pollutant; (2) there exists a reasonable likelihood that exposure to such substance causes or significantly contributes to injury or disease of the class or type which the claimant claims to have suffered, then it shall be presumed that the pollutant caused or significantly contributed to that injury or disease, and (3) such exposure was in a quantity or for a duration with respect to which there is a reasonable likelihood that it is sufficient to cause or significantly contribute to injury or disease of the class or type of which the claimant complains.[278]

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* Proving "legal" causation (that which will sustain recovery) actually embodies two legal concepts: proving cause in fact, and proving proximate causation. Proving cause in fact requires the plaintiff to establish that the defendant's conduct is a "material element and a substantial factor" in bringing about an event. W.L. Prosser, Law of Torts, 4th Ed., p. 240 (1971). See generally, W. Malone, "Ruminations on Cause-In-Fact," 9 Stan. L.R. 60, 91 (1956). Proximate causation, however, is essentially a legal policy question. Even if a defendant's conduct is considered a cause in fact of the plaintiff's injuries, the law will not provide redress unless the plaintiff can show that the defendant's conduct is the proximate cause of his injuries. Essentially this is a "question of whether the policy of the law will extend the responsibility for the conduct to the consequences which have in fact occurred." Prosser, supra, at 244.

This provision aids victims in three primary ways. First, it allows recovery even if the claimant is unable to identify which manufacturer of the pollutant caused the harm. Second, at each step the claimant need only prove that there was a "reasonable likelihood" that the pollutant was related to his injuries, rather than requiring the claimant to show that the pollutant was a "material and substantial factor" in causing his injuries. Finally, once this showing is made, the provision creates a rebuttable presumption of causation in favor of the claimant. If this presumption cannot be rebutted, the claimant is entitled to recover from the fund.

In cases involving suits directly against a manufacturer(s), the collective liability system would add the following language to the prior provision:

> If the claimant introduces evidence sufficient to show that it is reasonably likely that a chemical manufactured by the defendant caused or significantly contributed to injury or disease of the class or type of which the claimant complains, then it shall be presumed that the defendant caused or significantly contributed to that injury or disease.

If the defendant is unable to rebut this presumption, joint and several liability for the full set of statutorily specified damages follows. Significantly, under this provision the plaintiff need not demonstrate that the defendant was the cause in order to recover. The claimant is required to prove only that it is reasonably likely that the defendant caused or contributed significantly to his injuries.

These presumptions may also be invoked in favor of the fund. After payment of a claim, the fund acquires the rights of the claimant by subrogation. Where it is possible for the fund (whose representatives presumably will have great expertise in this area) to identify the party responsible for the claimants' injuries, the fund may recover its disbursements from the culpable party.

The statute of limitations under the proposed system incorporates a modification of the "discovery" rule. It allows a claim or suit within three years after the injury was diagnosed and reasonably could have been connected with exposure to the chemical. In contrast to a statute of limitations that begins to run on first exposure to a harmful substance, this is a fairly "liberal" rule. Because the health risks posed by toxic substances have not been established clearly, and because it is often difficult to identify the cause of particular diseases, this is an appropriate limitations period to apply to toxic substance injuries.

5. Recovery of Damages

Claims may be made against the fund for disability payments, medical expenses, and other medical benefits, including monitoring and testing. Disabilities shall be specified by rule, but should be liberally prescribed. Thus, for example, benign tumors should be compensable. Disability payments should be based on the degree of disability and the higher of the actual wage of the victim or the average wage in the state. Survivors benefits are also allowed.

In a direct action against a manufacturer, as opposed to a claim, similar damages are recoverable. In addition, however, if the plaintiff can prove that willful and wanton misconduct was involved, limited punitive damages are available from the defendant. Double court costs may also be obtained from the culpable manufacturer(s), half of which, in turn, is recoverable by the manufacturer from the fund. The total court costs and punitive damages, however, may not exceed 50 percent of the award for medical payments, disability, and other medical benefits.

Duplicative recoveries for the same injuries are not permitted. Therefore, any benefits received under Social Security, Disability Insurance, Medicare, and Medicaid for related injuries must be offset by the amount of the compensation obtained under the proposed system.

The proposed mechanism is intended to provide the exclusive means of recovery for personal injuries arising out of exposure to pollutant. However, claims for damages not involving personal injuries remain unaffected.

6. Financing

A key element of the system being studied is the trust fund. Financed by industry contributions, the fund acts as a source of residual liability when a victim is unable to identify the specific manufacturer responsible for his or her injuries. In such cases, if the fund can identify the manufacturer it may, through subrogation, recover payments made to claimants. This provision recognizes that fund representatives may be more experienced in such matters and, therefore, more capable of recovering from the culpable parties. If the fund cannot identify the manufacturer, it and in turn the entire industry bear the costs of the claim. In addition, if the manufacturer is unable to pay for the victim's injuries, for example due to bankruptcy, the fund provides a source of recompense. Finally, fund monies are used indirectly as an incentive to identify culpable parties. The fund, in effect, provides the successful plaintiff with a financial reward by granting him monies equal to his court costs, up to certain prescribed limits. The liable manufacturer, in addition to medical expenses and disability, is required to pay for up to twice the plaintiff's actual costs. Half of these additional costs may be recouped from the fund by the manufacturer. However, the net effect is that the fund provides a positive financial incentive to the plaintiff to identify the specifically responsible manufacturer.

Contributions to the fund should be based on both the financial needs of the fund and the risk of the contributors' activities. The financial needs of the fund should reflect the amount of past and expected claims and the amount of claims for which the fund has been unable to recover. Periodic adjustment of fund contributions should be allowed to ensure that fund levels remain adequate.

Estimating the risk associated with the activities of fund contributors, however, is a more challenging and controversial task. However, it is not without precedent in federal legislation. Numerous federal funding mechanisms impose fees on various activities that tend to cause harm. Under the Outer Continental Shelf Lands Act, for example, a fee is imposed on the amount of oil obtained from the Outer Continental Shelf (OCS). This provides a source of recompense for oil pollution damages from activities in the OCS. Similarly, under the Surface Mining Control and Reclamation Act, a tax is levied on the amount of coal extracted from surface mines. These monies are then used to fund mine reclamation activities. Finally, the Superfund law incorporates a fee system that is designed specifically to reflect the risks associated with each substance.[279]

Thus, it may be possible to base fund contributions, in part, on levels of production of the chemical. Alternatively, it may be more appropriate to base fund contributions on the amount of the manufactured chemical that may come in contact with human beings. Athough it may be more difficult to estimate the latter figure, it would probably provide a better representation of the human health risks involved. Consequently, the individual contributions would approximate more closely the potential fund expenditures attributable to the activities of individual contributors.

I. TOXIC CHEMICALS: THE NEED FOR INTERVENTION

A. Theoretical Framework

Pollution imposes three general types of costs on society: the costs of harm itself, *e.g.*, medical bills, pain, and lost wages; the costs of avoiding that harm, *e.g.*, pollution control techniques; and the "transaction" costs incurred in allocating and controlling harm, *e.g.*, litigation, negotiation, or regulation.[30] In an imaginary world with no transaction costs, society would allocate resources so as to minimize the aggregate costs associated with toxic substances regardless of the legal rules of liability.[31] A party that caused pollution and persons affected by the pollution would strike bargains leading to an economically efficient outcome.[32] That outcome would be dictated strictly by the costs of harm and the costs of preventing that harm.[33]

In a society *with* transaction costs, however, particular rules of liability can lead to a variety of economically inefficient outcomes.[34] Transaction costs in the legal system tend to favor polluters. In general, pollution is not penalized until the harm to individuals exceeds their transaction costs, because not until that point will the victims initiate litigation. Transaction costs associated with attempting to prove that a

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[30] *See, e.g.*, G. CALABRESI, THE COSTS OF ACCIDENTS 24–33 (1970); *see also* Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 44 (1960); Note, *Allocating the Costs of Hazardous Waste Disposal*, 93 HARV. L. REV. 584, 585 (1981). Transaction costs can include the administrative, legal, and other costs of regulatory and judicial decisionmaking, obtaining necessary information, valuing harm, and negotiating economically desirable bargains.

[31] *See* Coase, *supra* note 30, at 8 (Coase's Theorem); Zerbe, *The Problem of Social Cost: Fifteen Years Later*, in THEORY AND MEASUREMENT OF ECONOMIC EXTERNALITIES 29 (S. Lin ed. 1976) (discussion of Coase's Theorem, especially the importance of transaction costs).

[32] For example, imagine that citizens, rather than polluting sources, are liable for pollution, and that controlling a particular type of pollution would "cost" a polluting facility $75. If the polluter caused private citizens $100 "worth" of harm (comprising the net value to those citizens of *all* health, environmental, and other impacts of the pollution), these citizens theoretically would be willing to pay the polluter $85 *not* to engage in the activity. The polluter would be happy (having received more than the $75 it would gain by polluting), and the citizens would be $15 better off than they would have been if the polluting facility continued to pollute.

Conversely, if the facility were liable to the citizens for the $100 cost, it would refrain from polluting because the costs of pollution exceeded the $75 cost of control. Either way, in a world without transaction costs, the facility will not pollute when the costs of harm exceed the costs of control, and the facility will (and logically should) pollute when they do not. The economics of harm and preventing harm will dictate conduct and ensure an economically efficient result. *See* Coase, *supra* note 30, at 7–8; Dahlman, *The Problem of Externality*, 22 J.L. & ECON. 141, 142 (1979).

[33] Although the economically efficient outcome would always occur, the *distribution* of costs would not necessarily be invariant under all rules of liability. *See* Auten, *Discussion*, in THEORY AND MEASUREMENT OF ECONOMIC EXTERNALITIES 37–38 (S. Lin ed. 1976).

[34] Demsetz, *When Does the Rule of Liability Matter*, 1 J. LEGIS. STUD. 13, 26 (1972) ("Significant transacting cost implies that the rule of liability generally will have allocative effects . . . .").

(Excerpted from: Jeffrey Trauberman. Statutory Reform of "Toxic Torts": Relieving Legal, Scientific, and Economic Burdens on the Chemical Victim. Reproduced with the permission of the copyright holder from Harvard Environmental Law Review, v. 7, no. 2, 1983: 184-206. Originally published as an Environmental Law Institute report.

polluter was "at fault" may thus adversely affect social resource allocations.[35] As transaction costs associated with pollution increase, the polluter profits disproportionately at the expense of others, leading to economic "externalities."[36] Intervention may then be appropriate to reduce transaction costs.[37]

Efficient operation of the market assumes the theoretical condition of no transaction costs, which itself assumes that all parties to the negotiations have complete information on all relevant issues.[38] Though perfect information does not exist in any field of human endeavor, deviation from the ideal is especially pronounced regarding toxic substances. Individuals at risk may be unaware that a substance to which they are exposed presents a hazard, because that substance may have little or no short-term effect on health.[39] Even where individuals do know that they are exposed to a hazardous substance, that exposure may be virtually involuntary if it occurs on the job[40] or through ambient air,[41] drinking water,[42] or food supplies.[43]

Exposures from "non-essential" sources such as certain consumer products could theoretically be avoided more readily.[44] A theory of rational risk-avoidance, however, presumes that exposed persons are capable of understanding the risks of harm.[45] In reality, the general public lacks the background to evaluate the factors that together determine risk: exposure levels, the types of harm that may result from exposure, and the likelihood that harm will occur. In many instances, current scientific information on these factors is incomplete.[46] Even where such information exists, members of the public may lack the ability to retrieve and comprehend it.

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[35] *See, e.g.*, Bergman, *No Fault Liability for Oil Pollution Damage*, 5 J. Mar. L. & Com. 1, 37–38 (1973). As defined under the Hicks-Kaldor criterion, an "undesirable" resource allocation is one that results in a net decrease in the value of goods and services produced by such resources. *See supra* note 23; *infra* note 148.

[36] Professor Carl Dahlman therefore argues that the existence of an "externality" is merely indicative of an underlying transaction cost, which interferes with economic bargaining toward a theoretically efficient economic outcome. *See* Dahlman, *supra* note 32, at 142.

[37] This assumes, of course, that the intervention itself will not be too costly. *See* Calabresi, *Transaction Costs, Resource Allocation, and Liability Rules — A Comment*, 11 J.L. & Econ. 67, 69 (1968).

[38] *See* Zerbe, *The Problem of Social Cost: Fifteen Years Later*, in Theory and Measurement of Economic Externalities 31 (S. Lin ed. 1976); Calabresi, *supra* note 37, at 68 n.5; Latin, *Environmental Deregulation and Consumer Decisionmaking Under Uncertainty*, 6 Harv. Envtl. L. Rev. 187, 191–93 (1982).

[39] *See supra* note 17 (discussing lead).

[40] A choice may be considered voluntary when it is made without coercion and with adequate information. Choosing between a job and health may be tantamount to coercion although, in a strict economic sense, some may view the potential harm to health as merely a "cost" weighed in the worker's own cost-benefit analysis of accepting particular employment. *See* Graham & Shakow, *Hazard Pay for Workers: Risk and Reward*, Environment, October 1981, at 14. In addition to the fact that workers may not have the luxury of choosing among employers, where a high degree of uncertainty exists as to the possibility of harm and avoiding that harm, it is inequitable to expect a worker to be capable of accurately assessing the "costs" of employment in the particular enterprise. Thus, such a "choice" can not be viewed as entirely voluntary. *See* Derr, *The Nature of Consent*, Environment, October 1981, at 15. *See generally* Latin, *supra* note 38, at 223–28.

[41] *See supra* note 7.

[42] *See supra* note 6.

[43] *See supra* note 8.

[44] *But see* S. Epstein, *supra* note 3, at 150–51.

[45] W. Lowrance, Of Acceptable Risk: Science and the Determination of

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Safety (W. Kaufman ed. 1978). Even smoking may be viewed, in significant part, as an involuntary risk. Aggressive advertising of tobacco products, minimal "warning labels," governmental subsidies to tobacco growers, and the addictive properties of tobacco suggest that smoking is far less voluntary than some tobacco industry representatives might admit. Even if one assumes that the risks of lung cancer are well known to smokers, consumers have relatively little information on the associations between tobacco use and diseases other than lung cancer, such as heart disease, pulmonary impairments, and transgenerational effects. *See generally* U.S. Dep't of Health & Human Services, The Health Consequences of Smoking Generally for Women: A Report of the Surgeon General (1980); U.S. Dep't of Health Educ. & Welfare, Smoking and Health: A Report of the Surgeon General (1979). *See also* R. Doll & R. Peto, The Causes of Cancer 1221 (1981). One is hard-pressed to suggest that smoking is entirely a voluntarily assumed risk, especially with respect to serious hazards that are relatively unknown to the general public.

[46] The nascent and evolving scientific discipline that assesses the risks of hazardous substances merely allows scientists to make rough predictions about the effects of chemicals. *See generally* Leape, *Quantitative Risk Assessment in Regulation of Environmental Carcinogens*, 4 Harv. Envtl. L. Rev. 86 (1980) (discussing how the uncertainties inherent in quantitative risk assessment should be incorporated into decisionmaking).

Four primary risk assessment methodologies exist: (1) epidemiological evidence; (2) animal bioassays; (3) short-term tests; and (4) structure-activity correlations. Each of them is characterized by serious methodological shortcomings.

Epidemiology, the statistical study of disease occurrence in human populations, *see generally* F. Friedman, Primer of Epidemiology 1 (2d ed. 1980), is a relatively crude and insensitive tool and can be quite costly depending on the sample size. Ames, *Identifying Environmental Chemicals Causing Mutations and Cancer*, 204 Science 587, 587 (1979). More importantly, epidemiological evidence is of uncertain value as a tool for proving that a particular chemical was the cause of a specific disease in an individual. *See id.*; Dore, *A Commentary on the The Use of Epidemiological Evidence in Demonstrating Cause in Fact*, 7 Harv. Envtl. L. Rev. 429, 436 (1983); *see generally* Higginson & Muir, *The Role of Epidemiology in Elucidating the Importance of Environmental Factors in Human Cancer*, 1 Cancer Detection & Prevention 79, (1976) (epidemiological evidence analyzed to show that environmental agents can cause cancer and that in fact a large proportion of cancer is probably due to environmental factors); Monson, *Effects of Industrial Environment on Health*, 8 Envtl. L. 663, 664 (1978) (highlighting the difficulties of various types of epidemiological data by analyzing studies of several occupational populations, particularly of rubber workers).

Using animal bioassays to estimate health risks can also be cumbersome and costly. To detect relatively weak toxicants, large populations of animals must be studied. To detect reproductive effects, these studies must be conducted over several generations. Furthermore, improving the "resolving power" of these tests requires the use of high doses of chemicals. It is difficult to extrapolate from animals to humans, even for known metabolic pathways in both animals and humans. *See* B. Ames, Environmental Chemicals Causing Cancer and Genetic Birth Defects: Developing a Strategy to Minimize Human Exposure 19 (1978) (differences in metabolic pathways discussed); Bruce, *Low Dose Extrapolation and Risk Assessment*, Chem. Times & Trends, Oct. 1980, at 19; K. Crump, *The Scientific Basis for Health Risk Assessment* (paper presented at a seminar sponsored by George Washington University and the Environmental Protection Agency, Washington, D.C. (March 1982)).

The assumption of perfect information regarding toxic substances thus is seriously incorrect.[47] Nor does the private liability system compensate for this defect in the market. As a result, a number of commentators have concluded that the legal system fails to transfer or allocate the costs of toxic substances pollution efficiently.[48]

"Short-term" tests frequently involve microorganisms or tissue-cultures. In such tests, the cell populations are subjected to chemical agents and are then examined for mutations or other cellular abnormalities. No simple correlation exists between short-term test results and human health effects. *See* B. AMES, *supra*, at 11–22; Leape, *supra*, at 86; Ames, *supra*, at 591–92.

Structure-activity correlations are probably the least reliable method of quantifying risks because a small change in the structure of a chemical can dramatically alter its physiochemical properties. *See* Slesin & Sandler, *Categorization of Chemicals Under the Toxic Substances Control Act*, 7 ECOLOGY L.Q. 359, 372 (1978).

For an excellent discussion of the problems associated with risk assessment and hazardous substances, it is useful to examine the "cancer policy" issued by the Occupational Safety and Health Administration (OSHA). *See* 45 Fed. Reg. 5002 (1980) (as modified, codified at 20 C.F.R. § 1990 (1981)). OSHA's cancer policy has recently been partially suspended. 48 Fed. Reg. 241 (1983); *see also* W. LOWRANCE, *supra* note 45, at 12–74; S. EPSTEIN, *supra* note 3, at 37–70.

Additionally, it is extraordinarily difficult to monetize the value of a life, a natural resource, or a scenic view. Concerning the value of a life, see Pierce, *Encouraging Safety: The Limits of Tort Law and Government Regulation*, 33 VAND. L. REV. 1281, 1290–95 (1980); M. JONES-LEE, THE VALUE OF LIFE: AN ECONOMIC ANALYSIS (1976). Concerning the value of a natural resource, see Puerto Rico v. Zoe Colocotroni, 628 F.2d 652 (lst Cir. 1980); Halter & Thomas, *Recovery of Damages by States for Fish and Wildlife Losses Caused by Pollution*, 10 ECOLOGY L.Q. 5, 18–30 (1982); DuBey & Fidell, *The Assessment of Pollution Damages to Aquatic Resources: Alternatives to the Trial Model*, 19 SANTA CLARA L. REV. 641, 644–53 (1979); Wood, *Requiring Polluters to Pay for Aquatic Natural Resources Destroyed by Oil Pollution*, 8 NAT. RESOURCES LAW. 545, 600–08 (1975); Meyer, *Publicly Vested Values for Fish and Wildlife: Criteria in Economic Welfare and Interface with the Law*, 55 LAND ECON. 223, 223–29 (1979). Concerning the value of a scenic view, see Wood, *supra*, at 607.

It is even more difficult to apply the proper discount rate in order to monetize the present value of future harm to these commodities and services. Rodgers, *Benefits, Costs, and Risks: Oversight of Environmental Decisionmaking*, 4 HARV. ENVTL. L. REV. 191, 198 (1980).

47. *See* Latin, *supra* note 38, at 191–93 (arguing that the conventional economic theory which relies on the market to efficiently allocate resources invalidly assumes perfect knowledge on the part of the consumer).

In the absence of better information, individuals are often forced to rely on perceptions of risk that are incommensurate with the actual risks of harm. Studies suggest that people are very poor "risk perceivers," particularly when actual risks are relatively low. *See, e.g.*, Upton, *The Biological Effects of Ionizing Radiation*, 246 SCI. AM. 41, 48–49 (1982); Fischkoff, Slovic & Lichtenstein, *Weighing the Risks*, ENVIRONMENT, May 1979, at 17, 32–34. Consumers may perceive excessive risks due to media attention and publicity. For example, in 1980, the government released a report on chromosome damage in Love Canal residents, thereby causing hysteria and demands for evacuation. Even though many experts now believe that the report has zero scientific significance, the residents' fear and their perception of risks remain high. *See Love Canal: False Alarm Caused by Botched Study*, 208 SCIENCE 1239, 1239 (1980). On the other hand, focusing on the "carcinogen of the month" tends to desensitize people to risks. *See* S. EPSTEIN, *supra* note 3, at 32. Businesses are similarly affected by unfounded perceptions of risk. *See* Pierce, *Encouraging Safety: The Limits of Tort Law and Government Regulation*, 33 VAND. L. REV. 1281, 1301–02 (1980).

48. *See generally* INJURIES AND DAMAGES, *supra* note 14, at 115-17; Comment,

B. The Inadequacy of Private Damage Actions

Although a few federal and state statutes contain limited provisions for compensating toxics victims,[49] most injured citizens must rely on state common law theories — nuisance, negligence, trespass, and strict

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Hazardous Waste Liability and Compensation: Old Solutions, New Solutions, No Solutions, 14 Conn. L. Rev. 307, 317–25 (1982) (discussing the substantive and evidentiary inadequacies of common law theories for determining liability for hazardous waste injuries); Note, *Hazardous Waste: Third Party Compensation for Contingencies Arising from Inactive and Abandoned Hazardous Waste Disposal Sites*, 33 S.C.L. Rev. 543 (1982) (suggesting that a state or federal statutory cause of action be created and an administrative compensation fund be made available for third-party recovery for hazardous waste injuries); Rea, *Hazardous Waste Pollution: The Need for a Different Statutory Approach*, 12 Envtl. L. 443 (1982) (arguing that a compensation fund should be established to provide relief to victims of hazardous waste disposal, and that a federal toxic tort be created); Ginsberg & Weiss, *Common Law Liability for Toxic Torts: A Phantom Remedy*, 9 Hofstra L. Rev. 859 (1981) (evaluating the effectiveness of common law approaches to liability for personal injury and property damage in the context of the health emergency at Love Canal); U.S. Dep't of Labor, An Interim Report to Congress on Occupational Diseases (1980) (discussing the severity of occupational diseases, the inadequacy of existing compensation and disease prevention programs and the merits of alternative compensation systems); Six Case Studies, *supra* note 14; Note, *Strict Liability for Generators, Transporters, and Disposers of Hazardous Wastes*, 64 Minn. L. Rev. 949, 985–86 (1980) (arguing that victims of improper hazardous waste disposal base their claims on a combination of strict liability theories in view of current inadequate remedies); Note, *Toxic Substances Contamination: The Risk-Benefit Approach to Causation Analysis*, 14 U. Mich. J.L. Ref. 53, 55–60 (1980) (proposing the risk-benefit standard of causation in toxic contamination cases); Note, *An Analysis of Common Law and Statutory Remedies for Hazardous Waste Injuries*, 12 Rut.-Cam. L. Rev. 117, 122–50 (1980) (concluding that under traditional legal theories of tort, recovery for hazardous waste injuries often depends upon the effective presentation of reliable scientific evidence); Note, *Pursuing a Cause of Action in Hazardous Waste Pollution Cases*, 29 Buffalo L. Rev. 533 (1980) (discussing the need for modifying traditional elements of tort theory for hazardous waste injuries); Senate Comm. on Env't and Pub. Works., Environmental Emergency Response Act, S. Rep. No. 848, 96th Cong., 2d Sess. 10–12 (1980) (proposed legislation establishing strict liability and a rapid response mechanism, and assuring "prompt and adequate compensation for injured parties." *Id.* at 12); Milhollin, *Long-Term Liability for Environmental Harm*, 41 U. Pitt. L. Rev. 1, 5–16 (1979) (proposing the use of a liability fund, financed by taxing the source of hazardous substances risk); House Comm. on Pub. Works and Transp., 96th Cong., 1st Sess., Compensation for Victims of Water Pollution 18 (Comm. Print 1979) (analyzing several water contamination incidents and the resulting litigation, and discussing current legislative proposals for compensation of pollution victims); Soble, *A Proposal for the Administrative Compensation of Victims of Toxic Substances Pollution: A Model Act*, 14 Harv. J. on Legis. 683 (1977) (arguing that present costs and future risks associated with the development and production of new chemicals can be substantially reduced by a well-designed compensation program).

49. At the federal level, a variety of principles, statutes, and programs theoretically can provide compensation for environmental pollution. *See* Trauberman, *Compensating Victims of Toxic Substances Pollution: An Analysis of Existing Federal Statutes*, 5 Harv. Envtl. L. Rev. 1, 4–28 (1981); Injuries and Damages, *supra* note 14, at 52–54, 64–68; U.S. Dep't of Justice, The Superfund Concept: Report of the Interagency Task Force on Compensation and Liability for Releases of Hazardous Substances 31–40 (1979).

liability — and on state workers' compensation laws.[50] Each of these mechanisms has specific shortcomings, but certain themes cut across doctrinal lines. These legal and practical characteristics of "toxic tort" litigation illustrate the difficulty of using the existing legal system for recovering damages for toxic substances injuries.

1. Initiation And Settlement Of Legal Actions

Severe technical, legal, and economic obstacles surrounding recovery for toxic substances injuries may deter victims from initiating valid lawsuits, or may induce premature or inadequate settlements. Many victims fail to initiate an action because they do not even know that they have been harmed by a toxic substance.[51] Even those who are aware of their injuries may "choose" not to seek redress. A victim will rationally initiate legal action only if he or she calculates that the damage award will probably exceed the time, effort, and actual expenses of bringing suit.[52] Because of the complexities of proving toxic tort claims,[53] however, such litigation tends to be extremely expensive.[54] Thus, the degree of injury that triggers legal action in a toxics case will probably be higher than in other types of litigation.

States have a similar array of laws and principles governing compensation for harm caused by pollution. INJURIES AND DAMAGES, *supra* note 14, at 55–114; U.S. DEPT. OF JUSTICE, *supra*, at 16–30; SIX CASE STUDIES, *supra* note 14, at 13–58 (describing 12 candidate case studies and summarizing the applicable statutory and common law doctrines of the states involved); Note, *Compensating Victims of Occupational Diseases*, 95 HARV. L. REV. 916, 918 (1980); Meyers, *The Viability of Common Law Actions for Pollution Caused Injuries and Proof of Facts*, 18 N.Y.L.F. 935, 936–76 (1973). Furthermore, international treaties and conventions may be invoked to obtain damages or compensation for environmental pollution. *See* U.S. DEPT. OF JUSTICE, *supra*, at 40–43.

Even in the aggregate, however, these various mechanisms are considered inadequate for redressing harms suffered by private citizens. *See supra* note 48.

[50] *See generally* Ginsberg & Weiss, *supra* note 48; Note, *An Analysis of Common Law and Statutory Remedies for Hazardous Waste Injuries*, *supra* note 48; Note, *Environmental Health: An Analysis of Available and Proposed Remedies for Victims of Toxic Waste Contamination*, 7 AM. J.L. & MED. 61 (1981) (concluding that the common law is insufficient to redress toxic waste victims); Note, *Hazardous Wastes: Preserving the Nuisance Remedy*, 33 STAN. L. REV. 675 (1981); Note, *Strict Liability for Generators, Transporters, and Disposers of Hazardous Wastes*, *supra* note 48; Comment, *A Private Nuisance Approach to Hazardous Waste Disposal Sites*, 7 OHIO N.U.L. REV. 86 (1980) (concluding that the private nuisance action, though imperfect, is valuable and should not be abandoned for statutory remedies).

[51] *See, e.g.*, *supra* note 17 (discussing exposure to lead). It is thus extremely important to encourage efforts to notify potential toxics victims, *see* MODEL STATUTE § 207; *see also infra* notes 284–91 and accompanying text; and to educate the medical profession to recognize chemically caused injuries.

[52] *See* G. CALABRESI, *supra* note 30, at 135–36 (general discussion of the effects of transaction costs).

[53] *See supra* notes 39–48 and accompanying text.

[54] In proving their cases, toxic tort plaintiffs must usually rely on highly trained expert witnesses in medicine and science. Such witnesses often command a high hourly fee for preparing cases and for testifying. Unlike attorneys, expert witnesses generally

The large discrepancy between the number of toxics injury cases filed in particular jurisdictions, and the number of cases expected in such a population highlights the magnitude of the problem. Although comprehensive data on lawsuits for environmentally caused diseases are not available, several states maintain illustrative workers' compensation records. In Ohio, for example, only sixteen workers' compensation claims for occupationally caused cancer were filed during 1980.[55] The number of successful claims is even smaller; between 1977 and 1981, Colorado awarded compensation in only *six cases* of occupational cancer.[56] Even conservative estimates suggest that many times this number of persons have contracted cancers related to occupational exposures to hazardous chemicals.[57]

Additionally, scientific uncertainty affects the calculation of settlements in litigation involving hazardous chemicals. Settlements are generally desirable because they conserve time, money, and resources for all concerned — plaintiffs, defendants, and the courts. Unfortunately, the same burdens that may deter victims from initiating a lawsuit exist throughout the litigation. Toxics victims accordingly may tend to settle lawsuits earlier and for less money than other plaintiffs.[58]

Furthermore, settlement negotiations, like any negotiations, allocate costs optimally only if both parties are well informed.[59] Toxics victims rarely have as much scientific information as defendants, who are typically companies that produce, use, or distribute hazardous substances.[60] Consequently, for example, a victim of acute chemical poisoning or pollution may be unaware of potential chronic effects of that chemical, and may negotiate a settlement based on the harm that has manifested

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cannot be paid on a contingent fee basis. *See* Note, *Contingent Fees for Expert Witnesses in Civil Litigation*, 86 YALE L.J. 1680 (1977).

[55] *See* "Ohio: 1980 Lost-Time Occupational Disease Claims Involving Cancer," personal communication from Ellen R. Neiley, Research & Statistics Dep't, the Indus. Comm'n of Ohio, to Jeffrey Trauberman (June 1982) (on file at ELI).

[56] Letter from M. Noga, Dept. of Labor & Employment, State of Colorado (June 21, 1982) (on file at ELI). The highest level of compensation among the cases was $613. *Id.* Similarly, in the state of New York, only three occupational cancer claims were awarded compensation during 1978. STATE OF NEW YORK WORKER'S COMPENSATION BOARD, BULLETIN NO. 38, COMPENSATED CASES CLOSED, 1978, at 66 (1981). Overall, the number of disabling occupational diseases compensated by workers' compensation in the United States is proportionately far lower than in other developed countries in Western Europe. U.S. DEP'T OF LABOR, *supra* note 48, at 72.

[57] The "best estimate" by Doll and Peto suggests that about four percent of all cancer deaths can be attributed to occupational factors. R. DOLL & R. PETO, *supra* note 45, at 1256. Accepting these figures, about 16,000 occupational cancer deaths occur nationwide each year. In New York, with a little over 7.5 percent of the U.S population, roughly 1200 occupational cancer deaths would be expected annually on a proportional basis.

[58] *See* SIX CASE STUDIES, *supra* note 14, at 402–43 (discussing lead poisoning in Smeltertown, El Paso, Texas).

[59] *Id.* at 515 (conclusions).

[60] *Id.*

itself to date. Most settlement agreements do not allow the plaintiff to bring a later claim,[61] nor do courts usually allow a plaintiff to split a cause of action and bring multiple suits arising out of the same facts.[62]

The collective impact of these problems could result in proportionately fewer reports of cases involving toxics pollution. In turn, the lack of precedents may discourage victims and their attorneys from vigorously pursuing legal remedies, because they may not believe that they can win their cases.[63]

2. *Statutes of Limitations*

At the outset of considering litigation, the potential plaintiff faces an important threshold question: whether the statutory period within which suit may be brought has expired. Restrictive statutes of limitations pose special problems for pollution victims given the latent nature of many illnesses caused by hazardous substances. In the absence of acute effects, people may not even know that they have been exposed. Unaware of their injuries, they will not seek redress until the manifestation of symptoms — which may be a matter of decades. By then it may be virtually impossible to ascertain the causal agent and responsible person.

Recognizing the special problems that a short statute of limitations period presents for victims suffering from toxic torts, many states make exceptions to their general limitations period for torts.[64] In a large number of states the statute of limitations is not a bar, because in these jurisdictions the clock is started only after the victim has discovered or reasonably could have discovered the harm.[65]

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[61] Thus, future suits to recover for latent illnesses would be barred. *Id.* at 511.

[62] Restatement (Second) of Judgments § 25 comment c (1980).

[63] On the other hand, once causation is relatively well established, defendants may face extremely high damage awards. Two "problem" products which are of major concern to both the insurance and manufacturing industries are asbestos and diethylstilbestrol (DES). In an asbestos case, a $3 million single injury award was handed down in Beaumont, Texas, against a relatively small company. J. Mehaffy, *Asbestos-Related Lung Disease*, 16 Forum 341, 348 (1980). Thousands of asbestos cases are now pending. One major manufacturer of asbestos recently filed for bankruptcy in response to these suits. Its potential legal liability could "mean obligations totaling $2 billion, about $900 million more than the company's net worth." Granelli, *Manville Bankruptcy: The Battle is Beginning*, Nat'l L. J., September 6, 1982, at 5, 29. *See generally* Baldwin, *Asbestos Litigation and Collateral Estoppel*, 17 Forum 772 (1982) (offensive use of collateral estoppel by asbestos victims).

DES presents a similar situation. *See* Vagley & Blanton, *Aggregation of Claims: Liability for Certain Illnesses with Long Latency Periods Before Manifestation*, 16 Forum 636, 647–48 (1982). *See generally* Note, *Bearing the Burden of DES Exposure*, 60 Ore. L. Rev. 309 (1981) (proposing an administrative fund for compensating DES victims).

[64] *See* 1A F. Grad, Treatise on Envtl. L. § 4A.05 at 154 (1982) (compilation of all states' limitation periods for latent diseases).

[65] Birnbaum, *Statutes of Limitations in Environmental Suits: The Discovery Rule Approach*, Trial, April 1980, at 38; *see generally* Note, *Statutes of Limitations and Pollutant Injuries: The Need for a Contemporary Legal Response to Contemporary Technological Failure*, 9 Hofstra L. Rev. 1525 (1981) (proposing uniform statutes of limitations for pollution injuries). Thirty-nine jursidictions have adopted the discovery rule, by either

Several states, however, reject this rule. Of those, some accept the "continuous tort" principle, which holds that each new exposure triggers a new right of action.[66] This approach effectively excludes from compensation the large number of victims whose last exposure occurred in the relatively distant past. Furthermore, under the continuous tort doctrine, damages are not always available for harm caused before the particular exposure that triggered the right of action upon which the claim is based.[67] Thus, where victims suffer cumulative harm over a long period of time, redress for the effects of early exposures may not be available. A few states cling tenaciously to the even more restrictive "impact" rule, which starts the judicial clock running upon initial exposure to the hazardous substance.[68] This formulation effectively precludes virtually *all* claims by victims of latent or progressive diseases.

3. *Reasonableness*

The concept of "reasonableness" pervades common law standards of liability.[69] The failure to act in a reasonable fashion is the essence of the torts of negligence and nuisance; in order to determine whether behavior was reasonable, individual and social costs and benefits of that behavior are weighed.[70] A similar weighing takes place in more subtle ways under the doctrines of strict liability for abnormally dangerous

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statute or judicial interpretation. *See* INJURIES AND DAMAGES, *supra* note 14, at 118 n.4. A more recent formulation adopted by thirteen states starts the tolling of the statute from the time the injured party can ascertain a causal connection between the injury and the earlier exposure, or from the time the injured party should reasonably be able to do so. *See id.* at 30.

[66] *See, e.g.*, Garrett v. Raytheon Co., 368 So. 2d 516, 520–21 (Ala. 1979).

[67] *Id. See* Note, *supra* note 65, at 1539–41.

[68] Eight jurisdictions still follow this "traditional" rule and reject the discovery rule: Idaho, Virginia, Alabama, New York, Ohio, South Dakota, Wisconsin, and the Virgin Islands. F. GRAD, *supra* note 64, at 4A-158. In these jurisdictions, a plaintiff may be barred from bringing an action before he knows he has been hurt. *See* INJURIES AND DAMAGES, *supra* note 14, at 30.

[69] *See* Trauberman, *Risk-Benefit Analysis in Environmental Law: An Overview*, 3 J. ENVTL. PROF. 217 (1981).

[70] In general, the cost to the defendant and the social utility of the defendant's conduct are weighed against the harm to the plaintiff. *See* RESTATEMENT (SECOND) OF TORTS §§ 826–827 (1965). The *Restatement* lists several factors to be taken into account in assessing the utility of the defendant's conduct, including: the social value that the law attaches to the primary purpose of the conduct; the suitability of the conduct to the character of the locality; and the impracticality of preventing or avoiding the harm. *Id.* § 827. Similarly, the *Restatement* offers several factors to be considered in assessing the gravity of the harm to the plaintiff, including: the extent and kind of injury; the social value that the law places on the right allegedly invaded; and the ability of the persons harmed to avoid the harm. *Id.* § 826.

For a discussion of the theory of negligence, see W. PROSSER, HANDBOOK OF THE LAW OF TORTS 145–92 (4th ed. 1971). For a discussion of negligence in general economic terms, see Posner, *A Theory of Negligence*, 1 J. LEGIS. STUD. 29, 32–33 (1972). For a discussion of nuisance law, see W. RODGERS, ENVIRONMENTAL LAW 100–21 (1977).

activities[71] and strict products liability,[72] both of which impose liability for harm caused by certain activities regardless of whether the actor used reasonable care to avoid injuries.[73]

For a variety of reasons, cost-benefit analysis frequently results in inadequate recoveries by plaintiffs in toxic torts suits, or in the outright dismissal of their cases. Such plaintiffs tend to have great difficulty in establishing that the defendant behaved unreasonably in causing their exposure to that hazardous substance in question.[74] Evidence regarding exposure may be unavailable, either because such information was never compiled in the first place, or because it has been lost or discarded in the lengthy period between exposure and injury.

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[71] Section 520 of the *Restatement (Second) of Torts* outlines six factors that are important in determining whether an activity is abnormally dangerous:

> (a) existence of a high degree of risk of some harm to the person, land or chattels of others;
> (b) likelihood that the harm that results from it will be great;
> (c) inability to eliminate the risk by the exercise of reasonable care;
> (d) extent to which the activity is not a matter of common usage;
> (e) inappropriateness of the activity to the place where it is carried on; and
> (f) extent to which its value to the community is outweighed by its dangerous attributes.

RESTATEMENT (SECOND) OF TORTS § 520 (1976).

Factor "f" incorporates negligence or nuisance-type balancing into the calculus. If the value of the activity exceeds its dangerous attributes, an activity is not considered abnormally dangerous. *Id.* comment k. This criterion may "swallow the rule" of strict liability for abnormally dangerous activities by allowing a trial court to decide the question of negligence or nuisance at an earlier stage of the litigation.

Nevertheless, strict liability has been used to impose liability on defendants for a number of pollution-related risks. *See, e.g.*, Cities Service Co. v. State, 312 So. 2d 799 (Fla. App. Div. 1975) (storage of phosphate slimes); New Jersey v. Ventron, 182 N.J. Super. 210, 440 A.2d 445 (1981) (hazardous waste disposal); City of Bridgeton v. British Petroleum Oil, 146 N.J. Super. 169, 369 A.2d 49 (Super. Ct. Law Div. 1976) (fuel storage); Loe v. Lenhardt, 227 Or. 242, 362 P.2d 312 (1961) (crop dusting); Luthringer v. Moore, 31 Cal. 2d 489, 190 P.2d 1 (1948) (chemical fumigation); Frost v. Berkeley Phosphate Co., 42 S.C. 402, 20 S.E. 280 (1894) (air pollution).

[72] Under the *Restatement (Second) of Torts*, a seller of a product can be held strictly liable for harm to users or consumers of that product if it is sold in a "defective condition [which is] unreasonably dangerous." RESTATEMENT (SECOND) OF TORTS § 402A (1965). The *Restatement* calls this "strict liability." *Id.* § 402A comment a. However, as in sections 519 and 520, *see supra* note 71, a balancing of costs and benefits frequently occurs. *See* 2 INTERAGENCY TASK FORCE ON PRODUCT LIABILITY, PRODUCT LIABILITY: FINAL REPORT OF THE LEGAL STUDY 8–9, 40 (1977).

The critical balancing points involve the related definitions of "defective" and "unreasonably dangerous." The *Restatement* says that a product is "not in a defective condition when it is *safe* for normal handling and consumption." RESTATEMENT (SECOND) OF TORTS § 402A comment h (1965) (emphasis added).

With respect to unreasonable danger, the *Restatement* suggests that an item must be judged by reference to common knowledge as to its inherent dangers. RESTATEMENT (SECOND) OF TORTS § 402A comment i (1965). This, too, has been considered by some courts to allow negligence-based balancing. *See* Cronin v. J.B.E. Olson Corp., 8 Cal. 3d 121, 104 Cal. Rptr. 433, 501 P.2d 1153 (1972) (although other courts have criticized this decision). This approach may "impose[] a greater burden than even exists in a negligence case." L. FRUMER & M. FRIEDMAN, PRODUCTS LIABILITY 3B-165 (1982).

A third area in which section 402A allows balancing is in the realm of "unavoidably unsafe" products. Frequently, such cases involve drugs which are beneficial, but which may have serious side effects. RESTATEMENT (SECOND) OF TORTS, § 402A comment k (1965). It has been said that "the duty to warn depends on what is foreseeable — clearly a negligence concept." *Symposium on Products Liability*, 57 MARQ. L. REV. 623, 658 (1974).

[73] *See* W. PROSSER, *supra* note 70, at 494, 657.

Some courts have analyzed the reasonableness of a defendant's behavior retrospectively, *i.e.*, by assessing it in light of then-current knowledge.[75] In toxic tort litigation, plaintiffs usually must prove that a defendant's behavior unreasonably exposed them to a hazardous substance. For many substances, however, no regulatory standards for exposure existed at that time. Instead, plaintiffs must ascertain the risks actually known *and* theoretically knowable at the time of exposure, as well as the costs of determining those risks.[76] This technical information is not readily obtainable by most plaintiffs.[77] Nor is it easy for them to challenge the defendants' contentions on these points, because the defendants often have greater experience with these matters.[78] Thus, in order to establish fault, victims must produce data that is difficult and expensive to obtain and that probably falls within the expertise of the defendant.

Plaintiffs face a second major problem when courts attempt to apply "reasonableness" as a criterion in determining whether a defendant's conduct is actionable. The interests of the general public, beyond those of the particular litigants, often play an important though amorphous role in such disputes. In a lawsuit between two private parties, the interests of an individual plaintiff frequently are weighed against those of a larger group, such as an entire community or society as a whole.[79] However, society is comprised of diverse interests; the few clearly agreed-upon social goals often conflict with each other.[80] Thus, determinations of social costs and benefits are necessarily speculative.[81] Striking the balance between these various interests can be a subjective and arbitrary process,[82] because the courts may fail to consider the full range of interests adversely affected by the defendant's conduct. Predictably, the individual plaintiff tends to lose when courts look beyond the particular litigants to consider societal interests in support of the defendant's actions.[83]

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[74] *See* Pierce, *Encouraging Safety: The Limits of Tort Law and Government Regulation*, 33 VAND. L. REV. 1281, 1296–98 (1981).

[75] *See* New Jersey v. Ventron, No. 2996–75, slip op. at 49 (N.J. Super. Ct. Ch. Div. Aug. 27, 1979) ("While the discharge of mercury might be considered unreasonable, unwarranted, or unlawful by today's standards, the actions of the defendants must be measured as of the date they occurred."); *see also* Ginsberg & Weiss, *supra* note 48, at 886–920.

[76] *See* Ginsberg & Weiss, *supra* note 48, at 886–920.

[77] *See* Pierce, *supra* note 74, at 1297–98.

[78] Sometimes, the defendants' greater experience leads to exaggerated estimates of chemical control costs and underestimates of the potential health and environmental costs in the absence of controls. *See* Baram, *Cost-Benefit Analysis: An Inadequate Basis for Health, Safety, and Environmental Regulatory Decisionmaking*, 8 ECOLOGY L.Q. 473, 490 (1980).

[79] *See, e.g.*, Boomer v. Atlantic Cement Co., 26 N.Y.2d 219, 222–23, 309 N.Y.S.2d 312, 314–15, 257 N.E.2d 870, 871–72 (1970); *see also supra* note 70 and accompanying text.

[80] For example, society has an interest in keeping workers employed, profits high, and tax revenues stable. Yet, it also has an interest in keeping its populace healthy and its environment safe from pollution. These interests sometimes conflict. W. RODGERS, *supra* note 70, at 117.

The difficulty of quantifying costs and benefits is a third major problem faced by plaintiffs attempting to establish fault.[84] The legal,[85] technical,[86] and economic[87] literature is replete with discussions of this problem. Even when costs and benefits *can* be determined, assigning monetary values to non-pecuniary costs and benefits poses great problems.[88]

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[81] *See* Rodgers, *Benefits, Costs, and Risks: Oversight of Health and Environmental Decisionmaking*, 4 HARV. ENVTL. L. REV. 191, 196–98 (1980); Baram, *supra* note 78, at 481–92.

[82] Arbitrariness may occur even in the context of ostensibly agreed-upon goals. For example, eliminating disease would seem to be a goal characterized by a general societal consensus. However, achieving this goal conceivably could overburden retirement programs, increase unemployment and tax world food supplies. *See, e.g.*, Gori & Richter, *Macroeconomics of Disease Prevention in the United States*, 200 SCIENCE 1124, 1128–29 (1978). This is not at all meant to suggest that elimination of disease should not be heartily embraced as a societal goal; rather, it simply dramatizes the fact that pursuing even "utopian" goals almost always affects some people in adverse ways. Thus, the Hicks-Kaldor criterion is particularly useful in determining whether a specific consequence theoretically results in a net benefit to society. *See supra* note 23. Even the Hicks-Kaldor criterion, however, does not directly resolve theoretical and practical problems associated with distributing costs within society.

[83] *See* W. RODGERS, *supra* note 70, at 117–20; INJURIES AND DAMAGES, *supra* note 14, at 260; Pfennigstorf, *Environment, Damages, and Compensation*, 2 AM. BAR FOUND. RESEARCH J. 347, 360–61, 384 (1979). Some commentators have suggested that courts and regulatory agencies place disproportionate weight on the side of the more easily monetized costs of chemical control, and less weight on the more intangible and difficult to monetize benefits of control. *See generally* SENATE COMM. ON GOVERNMENTAL AFFAIRS, 96TH CONG., 2D SESS., BENEFITS OF ENVIRONMENTAL, HEALTH, AND SAFETY REGULATION (Comm. Print 1980) (collecting available data on the quantitative benefits of regulation).

[84] *See* G. CALABRESI, *supra* note 30, at 198–235 (difficulty in ascertaining costs); A. FREEMAN, THE BENEFITS OF ENVIRONMENTAL IMPROVEMENT (1979) (difficulty in ascertaining benefits).

[85] *See, e.g.*, Comment, *The Burden of Proof in Environmental and Public Health Litigation*, 49 UMKC L. REV. 207, 212–15 (1981) (discussing Reserve Mining Co. v. EPA, 514 F.2d 492 (8th Cir. 1975)); Rodgers, *supra* note 81, at 196–98; Green, *Cost-Risk-Benefit Assessment and the Law: Introduction and Perspective*, 45 GEO. WASH. L. REV. 901, 906–07 (1977); Baram, *supra* note 78, at 490.

[86] *See generally* Douglas, *Toward Better Methods of Risk Assessment*, EPRI JOURNAL, Mar. 1982, at 22 (discussing problems with present methods of risk assessment); Van Ryzin, *Quantitative Risk Assessment*, 22 J. OCCUPATIONAL MED. 321 (1980); Ricci & Molton, *Risk and Benefit in Environmental Law*, 214 SCIENCE 1096 (1981) (difficulty of quantifying risks).

[87] *See, e.g.*, L. ANDERSON & R. SETTLE, BENEFIT-COST ANALYSIS: A PRACTICAL GUIDE (1977); E. Mishan, *Cost-Benefit Analysis* (1976).

[88] *See supra* note 46. *See generally* Baram, *supra* note 78, at 193–96 (monetization of environmental values); L. ANDERSON & R. SETTLE, *supra* note 87, at 58–75.

Because it is difficult to determine the value of human life[89] and mental anguish,[90] courts must frequently make subjective decisions. Alternately, they may defer to more easily ascertained cost estimates, for example, by giving disproportionate consideration to the capital costs of preventing and controlling pollution.[91]

More generally, the cost-benefit balancing approach is impractical because it requires a court to make decisions far beyond its areas of expertise and, more likely, within the expertise of one of the litigants. For example, in deciding whether a defendant acted unreasonably in not testing a particular substance for a given health effect, the court must weigh factors from the realms of science, business, and policy.[92] Though typical industry practices at the time might guide the court, they do not decide the issue.[93] A court is free to decide that, weighing all the various interests, more should have been done, additional precautions should have been taken, or that the substance never should have been marketed or released into the environment. On the other hand, the court may decide that financial burdens overrode any potential duty to do more. Scientific and economic uncertainties provide an exasperatingly complex overlay to case-by-case judicial balancing, fueling claims that this approach leads to wholly arbitrary decisionmaking.[94]

In addition to being impractical, use of the cost-benefit balancing approach is not necessarily desirable. Under it, a defendant is not held liable for harm if the costs of preventing that harm exceed the total costs of such harm.[95] The fundamental assumption underlying this doctrine —

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[89] *See generally* M. JONES-LEE, *supra* note 46 (proposing an analytic framework for valuing life and safety); Zeckhauser, *Procedures for Valuing Lives*, 23 PUB. POLICY 419 (1975) (comparing and analyzing various methods of valuing human life in the realm of public decisionmaking).

[90] *See* Pierce, *supra* note 74, at 1293–95; Pfennigstorf, *supra* note 83, at 445.

[91] *See supra* note 83.

[92] *See generally* Bazelon, *Science and Uncertainty: A Jurist's View*, 5 HARV. ENVTL. L. REV. 1 (1981) (advocating that judges limit themselves to policing the processes of environmental decisions); Oakes, *The Judicial Role in Environmental Law*, 52 N.Y.U. L. REV. 498 (1977) (urging judicial activism in environmental law); Levinthal, *Environmental Decisionmaking and the Role of the Courts*, 122 U. PA. L. REV. 509 (1974) (advocating judicial restraint and the application of principles of administrative law to environmental law).

[93] *See supra* note 75.

[94] *See* Rodgers, *Judicial Review of Risk Assessments: The Role of Decision Theory in Unscrambling the Benzene Decision*, 11 ENVTL. L. 301, 302, 318 (1981); HOUSE COMM. ON INTERSTATE AND FOREIGN COMMERCE, 96TH CONG., 2D SESS., COST-BENEFIT ANALYSIS: WONDER TOOL OR MIRAGE? 32–34 (Comm. Print 1980). *See generally* Jasanoff & Nelkin, *Science, Technology, and the Limits of Judicial Competence*, 214 SCIENCE 1211 (1981) (arguing that judicial reform proposals concentrate on the problems of technical uncertainty and ignore the policy issues at stake).

[95] This is the classic test of fault-based liability. United States v. Carroll Towing, 159 F.2d 169, 173 (2d Cir. 1947) (L. Hand, J.); *cf.* Calabresi & Hirschoff, *Toward a Test for Strict Liability in Torts*, 81 YALE L.J. 1055, 1059 (1972). A defendant is not liable in three situations under a traditional fault-based system. These are: (1) where known risks

that chemical victims should bear the costs of pollution that is not "worth" avoiding — is both unjustified and unjustifiable. An improved legal and procedural system should be established to allocate and transfer these costs efficiently and fairly. A reformed system should allocate costs to the party *better able to make and act upon its own determination* of the costs and benefits of its activities.[96]

4. *Causation*

Scientific uncertainties and practical problems pervade toxic tort litigation.[97] These difficulties are especially severe in the context of proving causation. In order to prevail, a toxic tort plaintiff must show by a preponderance of the evidence[98] that the defendant's behavior was a substantial factor in causing his or her injury.[99] This task can be broken down into two factual issues: identifying which substance injured the plaintiff, and demonstrating that the defendant was responsible for injuriously exposing the plaintiff to that substance. In addition, the plaintiff must show that his or her injury was "proximately caused" by the defendant's behavior, *i.e.*, that the causal relationship between the exposure and the disease was foreseeable enough to deserve recognition by the law.[100]

a. *Identifying The Substance That Caused Harm*

Most toxic torts plaintiffs file suit seeking compensation for harm to their health. Unlike a bullet through the brain, the mechanisms by which

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are considered too costly for the defendant to protect against; (2) where unknown risks are theoretically knowable, but are considered too costly to discover or mitigate; (3) where risks are theoretically unknowable. *See* note 70. There is no theoretical reason that this need be true. Indeed, at least one scholar has questioned the assumption that individuals must suffer for the sake of social utility. *See* Fletcher, *Fairness and Utility in Tort Theory*, 85 HARV. L. REV. 537, 564–569 (1972).

[96] Calabresi & Hirschoff, *supra* note 95, at 1060.

[97] *See supra* text accompanying notes 30–63.

[98] W. PROSSER, *supra* note 70, § 41, at 241.

[99] *Id.* at 238. Only general disability and health insurance-type mechanisms obviate the need to demonstrate cause-in-fact as a prerequisite to recovery. *See generally* Trauberman, *supra* note 49, at 4–8.

As one commentator has explained:

> Under a rigid application of the "more likely than not" burden of proof, a plaintiff would recover only if there were better than a 50% chance that the defendant's conduct had caused *this* plaintiff's disease; thus the incidence of the disease in the group to which the plaintiff belongs would have to be more than twice the norm. For example, if a [hazardous waste] dump raised the annual number of cancers in an area from 20 to 25, a plaintiff among the 25 would be faced with the defense that there was only a one in five chance that his cancer was one of those caused by the dump. On the other hand, if the increase were from 20 to 41, every member of the class could demonstrate that his cancer was, more likely than not, caused by the dump.

Note, *Allocating the Costs of Hazardous Waste Control*, 94 HARV. L. REV. 584, 592 n.37 (1980).

[100] *See infra* text accompanying notes 119–24.

toxic substances cause disease are complex; they are the domain of the science of toxicology.[101] In attempting to establish that his or her disease was caused by a particular substance, a plaintiff must rely on expert witnesses from toxicology and related disciplines such as epidemiology. These experts generally base their testimony on scientific studies such as animal bioassays, epidemiological surveys, short-term screens for mutagencity, and structure-activity correlations.[102]

Such studies address issues of causality in terms of statistical probabilities. Traditionally, however, the courts have been reluctant to accept probabilistic evidence as showing causation.[103] As one commentator recently observed:

> "Does chemical Z cause cancer?" [is a question that] cannot be readily answered by the scientist. The scientist prefers to frame the question in terms of degree: "How carcinogenic is chemical Z?" Yet it is precisely the either-yes-or-no questions which the legal system addresses to a testifying scientist. That format rejects the same scientific method which provides the scientist with his expert status in the courtroom.[104]

Although courts are becoming more willing to accept statistical evidence — for example, in the context of proving racial discrimination[105] — this evidence thus far rarely has been determinative in cases concerning public health and environmental protection. The author is aware of no cases in which compensation has been awarded solely on the basis of such evidence. Courts that do rely on statistical evidence typically do so only in order to determine whether the risk from a particular activity or chemical warrants equitable (*i.e.*, non-compensatory) relief.[106]

This judicial reluctance reflects both the probabilistic nature of scientific data in this field and uncertainties regarding the interpretation of the data itself.[107] Although most scientists recognize the need to test animals with high doses of a substance in order to increase the resolving power of such a test,[108] some scientists and policymakers have been reluctant to extrapolate from these high doses to the lower doses to which humans are usually exposed.[109] Additional uncertainties arise in extrapolating between test animals and humans.[110] Most experts in the field of toxicology and related sciences agree, however, that such data does provide accurate information about the ability of various substances to cause chronic health effects in humans.[111]

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[101] *See supra* note 46.

[102] *See supra* note 46.

[103] Large & Michie, *Proving that the Strength of the British Navy Depends on the Number of Old Maids in England: A Comparison of Scientific Proof with Legal Proof*, 11 ENVTL. L. 557, 599 (1981); *see also* Hills, *Legal Decisions and Opinions in Pollution Cases*, 10 ENVTL. SCI. & TECH. 234 (1976) (reviewing four leading cases involving asbestos, lead, vinyl chloride, and the pesticide aldrin/dieldrin); Note, *Judicial Attitudes Towards Legal and Scientific Proof of Cancer Causation*, 3 COLUM. J. ENVTL. L. 344 (1977) (advocating greater judicial receptivity to scientific proof of cancer causation). *But cf.* Dickson, *Medical Causation by Statistics*, 17 FORUM 792 (1982) (criticizing recent California decisions admitting the testimony of epidemiologists in product liability cases).

[104] Large & Michie, *supra* note 103, at 595

[105] *See id.* at 602.

[106] *See, e.g.*, Drechsler, *Public Health Endangerment and Standards of Proof: Ethyl Corp. v. EPA*, 6 ENVTL. AFF. 227, 238–46 (1977); Comment, *supra* note 85, at 211 n.23.

[107] *See generally* Note, *supra* note 103; Large & Michie, *supra* note 103, at 598–606; Jasanoff & Nelkin, *Science, Technology, and the Limits of Judicial Competence*, *supra* note 94.

The plaintiff's task of proving causation is further complicated because the physiological mechanisms of chronic disease, particularly carcinogenesis, are not well understood. Many chronic diseases apparently result from multifactorial etiology — several factors at work together at the same time — and substances may interact in complex ways to produce harm.[112] For example, some chemicals can accentuate or mute the effect of other substances.[113] Other chemicals, called promoters, are not themselves carcinogenic, but can cause carcinogenesis when combined with exposure to a chemical "initiator."[114] As a result of these complexities, plaintiffs can seldom refute a defendant's contention that some other chemical exposures caused their injury. A toxicologist appearing as an expert witness for the plaintiff may be able to state with assurance that exposure to a particular level of substance X is capable of causing an increase of disease Y in the exposed population. That witness, however, can seldom testify that the individual plaintiff's disease was caused by exposure to the particular defendant's toxic substance. Thus, the traditional concept of causation may stand as an insuperable barrier to recovery of damages by many plaintiffs injured by toxic substances.

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[108] Typically, one hundred rats are used in a particular test, because economic constraints prevent the testing of larger populations. To conduct a test sensitive enough to assess unacceptable lifetime human health risks on one hundred animals, it is necessary to conduct such tests with high doses. *See* Bates, *Laboratory Approaches to the Identification of Carcinogens*, 271 ANNALS N.Y. ACAD. SCI. 29, 30–32 (1976); Interagency Regulatory Liaison Group, *Scientific Bases for Identification of Potential Carcinogens and Estimation of Risks*, 44 Fed. Reg. 39,857, 39,864–65 (1979) [hereinafter cited as IRLG Report]. Extrapolations of dose-response curves permit the scientists to assess the effects of exposure levels that are much lower than those used in the laboratory. These predictions, however, assume that the responses observed under large laboratory dosages can be used to predict responses at the much smaller dosages that humans are likely to encounter. IRLG Report, *supra*, at 39,871. It is unclear whether linear, sigmoidal, or other low dose extrapolations are appropriate. *See generally* Van Ryzin, *Quantitative Risk Assessment*, 22 J. OCCUPATIONAL MED. 321 (1980) (reviewing four current models for low-dose extrapolation); *see also supra* note 46 (discussing the difficulties inherent in chemical risk assessments); Hoel, Kaplan & Anderson, *Implication of Nonlinear Kinetics on Risk Estimation in Carcinogenesis*, 219 SCIENCE 1032 (1983) (arguing that current low dose extrapolations overestimate cancer risks).

[109] *See* IRLG Report, *supra* note 108, at 38,872–73 (discussing extrapolation models); Kirschman, *Toxicology–The Exact Use of an Inexact Science*, FOOD DRUG COSM. L.J., Aug. 1976, at 455, 458–59.

[110] *See, e.g.*, Dry Color Mfrs. Assoc. v. Dep't of Labor, 486 F.2d 98, 104–105 (3d Cir. 1973) (vacating emergency standards for occupational exposure to chemicals shown to be carcinogenic in animals because "evidence supplies no more than some possibility that [the chemicals] may cause cancer in man"); *see also* Large & Michie, *supra* note 103, at 592–93; S. EPSTEIN, *supra* note 3, at 53; McGovern, *Toxic Substances Litigation in the Fourth Circuit*, 16 U. RICH. L. REV. 247, 297 (1982). Reform may gradually occur in this area, as courts are beginning to relax their standards of acceptability for scientific evidence. *See* Note, *Changing the Standard for the Admissibility of Novel Scientific Evidence:* State v. Williams, 40 OHIO ST. L.J. 757, 769 (1979) (noting that Maine, and to some extent Massachusetts, are liberalizing their standards); Synthetic Organic Chem. Mfrs. Assoc. v. Brennan, 503 F.2d 1155, 1157 (3d Cir. 1974) *cert. denied*, 420 U.S. 973 (1975) (upholding occupational exposure standard based on animal test data alone).

[111] *See* IRLG Report, *supra* note 108, at 39,862.

[112] U.S. DEP'T OF HEALTH EDUC. & WELFARE, *supra* note 9, at 267–76 (discussing biological mechanisms and determinants of toxicity).

[113] *Id.*

b. Identifying The Party Responsible For Harm

Lawsuits must name people, businesses, or other organizations as defendants. Even if victims can identify the chemical agent that caused their diseases, they still must show who was responsible for their exposure to that substance. This is especially difficult in highly industrialized settings where there are many possible sources of exposure.[115] For example, a plaintiff may be exposed to substance X in drinking water, but substance X may also occur as a contaminant in the plaintiff's workplace. In order to win, the plaintiff must show that it is more probable than not that his or her disease was caused by exposure to X through drinking water rather than in the workplace.[116] Furthermore, if a disease expresses itself long after exposure to a chemical, evidence as to its source and exposure pathways may be lost and the memories of witnesses may fade.[117]

Even after a victim has identified a substance and a potentially liable party, sometimes it is impossible to recover from that party. A company that once contaminated the environment may no longer exist; it may have declared bankruptcy or otherwise ceased to do business;[118] or it may lack the financial resources to compensate victims fully. Thus, practical realities as well as traditional conceptions of causation may limit compensation.

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[114] *Id.* at 287–93 (discussing mechanisms of carcinogenesis).

[115] *See, e.g.*, In the Matter of the Compensation of Donald R. Anderson, 57 Or. App. 770, 646 P.2d 1352, 1354 (1982) ("[Claimant] must establish more than a mere possibility that the on-the-job circumstances were the major contributing cause of the disability.").

[116] *See supra* note 99.

[117] This difficulty arose in the diethylstilbestrol (DES) litigation, where a drug given to pregnant mothers later increased the incidence of cancer in their female children. The California Supreme Court dealt with the problem by imposing "market share" liability. *Sindell v. Abbott Laboratories*, 26 Cal. 3d 588, 607 P.2d 924, 163 Cal. Rptr. 132, *cert. denied*, 449 U.S. 912 (1980). *See infra* notes 343–351 and accompanying text. Other courts have invoked joint and several liability in similar circumstances. *See, e.g.*, Michie v. Great Lakes Steel, 495 F.2d 213 (6th Cir. 1974), *cert. denied*, 419 U.S. 997 (1974).

[118] *See* S. REP. No. 848, *supra* note 48, at 15; Milhollin, *supra* note 48, at 8–9; *see also Manville Bankruptcy: The Battle is Beginning*, NAT'L L.J., Sept. 6, 1982, at 5; Note, *The Manville Bankruptcy: Treating Mass Tort Claims in Chapter 11 Proceedings*, 96 HARV. L. REV. 1121 (1983).

c. *Proximate Causation And Uncertainty*

In addition to identifying the chemical and the party responsible for harm, a plaintiff must prove that the defendant's actions or omissions were the "proximate cause" of his or her injuries.[119] The term proximate cause is a misnomer, given that the underlying concept has little to do with the proximity in time or space of cause and effect. Instead, it denotes the policy judgment that some effects of a defendant's behavior are so unexpected that the law will refuse to impose liability for the resulting harm.[120]

Unfortunately, however, judges and juries may intuitively look for proximity of cause and effect between a defendant's behavior and the plaintiff's injury. A victim of latent disease, complaining of an injury that by its very nature is remote from the defendant's allegedly injurious conduct, may be especially likely to lose on this ground.[121] Furthermore, a defendant may raise proximate causation issues in a number of different contexts within the same case. In a negligence action, for example, the plaintiff must establish that the risks of his or her injury were foreseeable.[122] A court will deny recovery for injuries resulting from an unforeseeable toxicological risk.[123] Even if the plaintiff meets this burden, the court may reexamine the issue of foreseeability in the guise of determining whether the foreseeable risks were *proximately* caused by the defendant.[124] In effect, the plaintiff may be forced to establish repeatedly a sufficiently close (*i.e.*, "proximate") connection between the defendant's conduct and the harm incurred.

5. *Inconsistent and Inequitable Damage Awards*

Damage awards under the existing tort system are often arbitrary and unfair to plaintiffs and defendants alike. Among other shortcomings, the law of damages has failed to address the problem of valuing human life and health.[125] In many circumstances, the amount of damages awarded depends on characteristics of the victim.[126] The number of dependents and the income of the victim often are important factors in determining damages,[127] though it is questionable whether a society that aspires to democratic ideals should thus value the life of a highly paid executive more than that of a semi-skilled worker. In addition, personal injury awards treat non-pecuniary harm, such as pain and suffering and loss of consortium, in a subjective manner.[128]

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[119] W. Prosser, *supra* note 70, at 244.

[120] *Id.* at 244–45. *See* Thode, *Tort Analysis: Duty–Risk v. Proximate Cause and the Rational Allocation of Functions Between Judge and Jury*, 1977 Utah L. Rev. 1, 27.

[121] *See* Note, *supra* note 103, at 344, 362–68 (1977).

[122] W. Prosser, *supra* note 70, at 250–70.

[123] *Id.* Some of the substances that have been recognized as the most dangerous pollutants (selected heavy metals, PCBs, PBBs, and certain pesticides) had long been considered relatively harmless for humans, and therefore had been widely used and released into the environment. A defendant who exposed people to these substances could avoid liability on a negligence theory, unless the plaintiff could show that the defendant continued to expose individuals to these substances after he had recognized or should have recognized, their harmful nature. *See supra* note 75.

[124] *See* W. Prosser, *supra* note 70, at 244–46 (discussing the confusion that arises in considering proximate causation and the appropriate standard of duty in a negligence action).

Society could benefit by the development of guidelines for better, more uniform pollution damage awards. Such guidelines should be specific enough to reduce arbitrary and unjustified awards, but flexible enough to allow for variations among particular plaintiffs and defendants.[129] Under the current legal system governing toxic substances injuries, caprice, rather than rationality, too often carries the day.[130] A host of commentators urge reform.[131]

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[125] *See supra* note 46.

[126] In wrongful death actions, for example, the average award for the death of a child is only $28,355, while the average damage award for the death of an adult male is $240,228. As Professor Pierce notes, it is doubtful that society should encourage firms to spend only one-eighth as much to prevent the death of a child as to prevent the death of an adult male. Pierce, *supra* note 74, at 1293.

[127] *Id.* at 1291–93. There are two approaches to calculating damages for wrongful death: loss to survivors and loss to estate. The majority of states adopt the former approach and thus "determine the amount of money that the victim would have provided to his dependents if his life had not been prematurely terminated." *Id.* at 1291–92.

[128] In many cases, personal injury awards are comprised predominantly of damages for pain and suffering. Pierce, *supra* note 74, at 1293.

[129] Pierce, *supra* note 74, at 1321–22. 7 INTERAGENCY TASK FORCE ON PRODUCT LIABILITY, *supra* note 72, at 69.

[130] *See* Soble, *supra* note 48, at 683; Ginsberg & Weiss, *supra* note 48; Rea, *supra* note 48, at 443; Note, *Liability for Generators of Hazardous Waste: The Failure of Existing Enforcement Mechanisms*, 69 GEO. L.J. 1047, 1051–65 (1981). *See generally* INJURIES AND DAMAGES, *supra* note 14 (analyzing the remedies available under CERCLA); Note, *Allocating the Costs of Hazardous Waste Disposal*, 94 HARV. L. REV. 584 (1981) (comparing existing mechanisms for allocating the costs of hazardous wastes); Mott, *Liability for Cleanup of Inactive Hazardous Waste Disposal Sites*, 14 NAT. RESOURCES LAW. 379 (1982) (discussing the methods of imposing liability for the cleanup costs of hazardous waste sites).

[131] *See, e.g.*, Soble, *supra* note 48; Trauberman, *Compensating Victims of Toxic Substances Pollution: An Analysis of Existing Federal Statutes*, 5 HARV. ENVTL. L. REV. 1, 28–29 (1981). Among the reform bills proposed in the First Session of the Ninety-eighth Congress are: H.R. 2330, H.R. 2582, S. 917, S. 945, and S. 946. Other recent proposals for reform include: (1981); S. 1046, 96th Cong., 1st Sess (1979); H.R. 5291, 96th Cong., 1st Sess. (1979); H.R. 3798, 96th Cong., 1st Sess. (1979); H.R. 1049, 96th Cong., 1st Sess. (1979); O'Connell, *Foreclosing Claims for Personal Injury From Toxic Substances by Defendants' Tender of Claimants' Net Economic Losses*, 2 VA. J. OF NATURAL RESOURCES L. 203, 203–11 (1983). At the state level, New Jersey is one of the forerunners in enacting legislation available to private pollution victims. *See* The New Jersey Spill Compensation and Control Act, N.J. STAT. ANN. 58:10-23.11(a)–.11(z). Internationally, New Zealand and Japan have undertaken novel approaches to redress private damages, including those resulting from pollution. *See* Marks, *A First in National No-Fault: The Accident Compensation Act 1972 of New Zealand*, 47 AUST. L. J. 516, 517–18 (1973); Gresser, *The 1973 Japanese Law for the Compensation of Pollution-Related Health Damage: An Introductory Assessment*, 5 ENVTL. L. REP. (ENVTL. L. INST.) 50,229 (1975).

C. The Failure of Regulation and Public Enforcement

A second option for minimizing the social costs of toxic substances is regulation by administrative agencies, combined with enforcement actions for violation of regulatory standards. The federal government has responded to toxic substances pollution primarily by creating elaborate regulatory schemes,[132] many of which beget substantial compliance costs.[133] These programs have proven difficult to implement and administer, even though governmental agencies possess resources that might allow them to overcome some of the scientific and technical uncertainties facing private individuals exposed to hazardous chemicals.[134]

First, statutory provisions authorizing regulatory actions emerge only from a highly politicized process, the outcome of which may not reflect the interests of exposed or injured individuals. Vested economic forces, representing well financed and well informed business interests, often dominate the legislative debate over health and environmental statutes.[135]

Second, statutory control of toxic chemicals is fragmented. At the federal level, no fewer than a dozen statutes under the jurisdiction of at least five federal agencies address hazardous substances.[136] This creates considerable confusion and inconsistency in the control of toxic substances, reflected in inefficient and ineffective regulatory action.[137]

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[132] *See, e.g.*, Toxic Substances Control Act, 15 U.S.C. §§ 2601–2629 (Supp. IV 1980); Resource Conservation and Recovery Act of 1976, 42 U.S.C. §§ 6901–6987 (Supp. IV 1980). A few statutes, however, do provide for liability for damages, rather than statutory prohibitions and penalties, as the means to protect the environment. *E.g.*, Federal Water Pollution Control Act, 33 U.S.C. §§ 1251–1376 (1976); Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. §§ 9601–9650 (1976 & Supp. IV 1980); Outer Continental Shelf Lands Act, 43 U.S.C. §§ 1331–1343, 1801–1866 (1976 & Supp. IV 1980); Deepwater Port Act, 33 U.S.C. §§ 1501–1524 (1976 & Supp. V 1981); Trans-Alaska Pipeline Authorization Act, 43 U.S.C. §§ 1651–1655 (1976 & Supp. IV 1980).

[133] *See* Note, *supra* note 30, at 602–03. For example, the estimated cost to industry of EPA's water pollution control program is *$18-19 billion each year* by 1985. *See* Bardach & Kagan, *Introduction*, in SOCIAL REGULATION: STRATEGIES FOR REFORM 6 (E. Bardach & R. Kagan eds. 1982).

[134] Federal governmental organizations have access to several data bases, not all of which are available commercially. For example, EPA has ENVIRON (Environmental Information Retreival On-Line) and PIM (Pesticide Incidence Monitory System); FDA has Poison Control Clearinghouse; National Academy of Sciences has Advisory Center on Toxicology; National Cancer Institute has CANCERLINE (Cancer Information On-Line). *See* ENVIRONMENTAL INFORMATION CENTER, TOXIC SUBSTANCES SOURCEBOOK 140–41 (1978) (Series 1).

[135] *See* S. EPSTEIN, *supra* note 3, at 419–28.

[136] The federal agencies and their associated statutes are: (1) the Occupational Safety and Health Administration, empowered by the Occupational Safety and Health Act, 29 U.S.C. §§ 651–678 (1976 & Supp. V 1981) (addresses workplace exposure to hazardous substances); (2) the Environmental Protection Agency, which regulates toxic chemicals under six statutes: The Federal Environmental Pesticide Control Act, 7 U.S.C. §§ 136–136y (1976 & Supp. V 1981) (addresses hazardous substances in pesticides); the Toxic Substances Control Act, 15 U.S.C. §§ 2601–2629 (1976 & Supp. V 1981) (addresses the marketing of toxic and hazardous chemicals); the Federal Water Pollution Control Act, 33 U.S.C. §§ 1251–1376 (1976 & Supp. V 1981) (addresses the introduction of hazardous substances into navigable waters); the Safe Drinking Water Act, 42 U.S.C. §§ 300f–300j

Furthermore, regulatory agencies themselves are subject to political pressures. The same vested interests that influence congressional action also tend to dominate regulatory agencies.[138] Consequently, politics plays an important role in determining the effectiveness of regulatory agencies.[139]

Fourth, although regulatory agencies possess greater resources than private citizens, their budgets are spread quite thinly. For example, in 1981 the U.S. General Accounting Office estimated that the federal government could only bring forty to fifty hazardous waste lawsuits each year, although several thousand problem waste sites had been identified.[140]

A fifth major disadvantage of regulation is that it does not encourage private sector research involving unknown environmental hazards. Regulation typically imposes a static set of responsibilities on the regulated

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(1976) (addresses the introduction of hazardous substances into sources of drinking water); the Resource Conservation and Recovery Act of 1976, 42 U.S.C. §§ 6901–6987 (1976 & Supp. IV 1980) (addresses the disposal of hazardous substances); the Clean Air Act, 42 U.S.C. §§ 7401–7642 (1976 & Supp. IV 1980) (addresses the introduction of hazardous substances into the air); and the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. §§ 9601–9657 (Supp. IV 1980) (provides for clean-up of hazardous substances discharges); (3) the Consumer Product Safety Commission, under the Consumer Product Safety Act, 15 U.S.C. §§ 2051–2081 (1976 & Supp. V 1981) (addresses hazardous substances in consumer products); (4) the Food and Drug Administration, exercising authority under the Food, Drug, and Cosmetic Act, 21 U.S.C. §§ 301–392 (1976 & Supp. V 1981) (addresses the use of hazardous food additives); (5) the Department of Agriculture, given limited authority under 21 U.S.C. §§ 601–695 (1976 & Supp. V 1981) (addresses hazardous substances in meat); and (6) the Department of Transportation, under 45 U.S.C. §§ 421–444 (1976 & Supp. IV 1980), 46 U.S.C. §§ 170–170b (1976 & Supp. IV 1980), 46 U.S.C. § 391(a) (1976 & Supp. IV 1980), and 49 U.S.C. §§ 1801–1812 (1976 & Supp. IV 1980) (four statutes addressing the transportation of hazardous materials by rail, water, or highway).

[137] *See, e.g.*, 5 Senate Comm. on Gov't Affairs, 95th Cong., 1st Sess., Study on Federal Regulation 307–39 (Comm. Print 1977); ABA Comm'n on Law and the Economy, Federal Legislation: Roads to Reform 14 (1979) (in general, the federal bureaucracy is a "haphazard deposit of irresponsible agencies and uncoordinated powers"). Despite the proliferation of federal statutes, some activities involving hazardous chemicals remain beyond the reach of national control. Groundwater pollution, for example, is not subject to extensive or uniform federal protection. *See* Tripp & Jaffe, *Preventing Groundwater Pollution: Towards a Coordinated Strategy to Protect Critical Recharge Zones*, 3 Harv. Envtl. L. Rev. 1, 9–25 (1979); Horne, *Groundwater Policy: A Patchwork of Protection*, Environment, April 1982, at 6.

[138] *See 3 Study on Federal Regulation, 1977: Hearings Before the House Comm. on Gov't Affairs*, 95th Cong., 1st Sess. 1–11 (1977).

[139] *See 1 Study on Federal Regulation, 1977: Hearings Before the House Comm. on Gov't Affairs*, 95th Cong., 1st Sess. 95–160 (1977).

[140] *See* U.S. Gen. Accounting Office, Pub. No. CED-81-57, Hazardous Waste Sites Pose Investigation, Evaluation, Scientific and Legal Problems 2, 38 (1981). Furthermore, based on the government's estimates of cleanup costs, the money available under the 1980 Superfund will not likely be able to address many of the sites considered hazardous. *Id.* at 41.

community. Generally, only the self-initiated action of the government changes those responsibilities.[141] One of the advantages of the private liability system is that it could, in theory, encourage industry to investigate unknown hazards;[142] upon discovering a hazard, the costs associated with private liability may inspire an enterprise to adopt safety precautions, even for unregulated substances.[143]

Sixth, rulemaking is a lengthy, time-consuming, and cumbersome process. For example, a 1977 study by the General Accounting Office suggested that, at the then-current rate, more than a century would be required to establish standards for known occupational hazards.[144] Federal and state regulatory agencies have continually been found to be ineffective in controlling hazardous chemicals.[145] Despite the best efforts of agency personnel, regulatory agencies may be fundamentally ineffective due to their centralized nature. Although large organizations often provide certain benefits from economies of scale, centralized regulatory agencies often cannot take full account of the myriad economic, technical, and other factors that affect regulated conduct at the local level.[146]

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[141] Some federal laws do contain provisions governing citizen petitions. *See, e.g.*, the Clean Air Act § 304, 42 U.S.C. § 7604 (1976); Federal Water Pollution Control Act § 505, 33 U.S.C. § 1465 (1976); Toxic Substances Control Act § 20, 15 U.S.C. § 2619 (1976); Noise Control Act of 1972 § 12, 42 U.S.C. § 4911 (1976); Resource Conservation and Recovery Act of 1976 § 7002, 42 U.S.C. § 6792 (Supp. IV 1980); Safe Drinking Water Act § 1449, 42 U.S.C. § 300j-8 (1976). However, such petitions rarely succeed because private citizens typically lack the resources to pursue such remedies vigorously. *See* 3 *Study on Federal Regulation, 1977: Hearings Before the House Comm. on Gov't Affairs*, 95th Cong., 1st Sess. 12–22 (1977).

In addition, some statutes attempt to incorporate "technology forcing" provisions. *See* Note, *Risk-Benefit Analysis and Technology Forcing Under the Toxic Substances Control Act*, 62 Iowa L. Rev. 942 (1977); Goldsmith & Banks, *Environmental Values: Institutional Responsibility and the Supreme Court*, 7 Harv. Envtl. L. Rev. 1, 16–20 (1983) (technology forcing provisions of the Clean Air Act).

[142] *See* Havender, *Assessing and Controlling Risks*, in Social Regulation: Strategies for Reform 21, 52 (E. Bardach & R. Kagan eds. 1982).

[143] *See id.*

[144] *See* U.S. Gen. Accounting Office, Delays in Setting Workplace Standards for Cancer-Causing and Other Dangerous Substances 9 (1977).

[145] *See* U.S. Gen. Accounting Office, Pub. No. CED-81-1, EPA is Slow to Carry Out Its Responsibility to Control Harmful Chemicals at i (1980); U.S. Gen. Accounting Office, Pub. No. CED-82-43, States' Compliance Lacking in Meeting Safe Drinking Water Regulations (1980) (investigating the reasons for the large number of violations of the Safe Drinking Water Act of 1974); U.S. Gen. Accounting Office, Pub. No. CED-82-5, Stronger Enforcement Needed Against Misuse of Pesticides (1981) (EPA and the States do not always adequately investigate or enforce pesticide law violations).

[146] *See* Bardach & Kagan, *supra* note 133, at 12–14. In addition, unlike a privately-owned business where profits are the motivating factor, agencies have little incentive to maximize efficiency. Without the empirical measure of performance by profits, procedural and paperwork burdens may interfere with an agency's substantive mandate. *See* U.S. Gen. Accounting Office, Pub. No. GGD-81-40, The Environmental Protection Agency Needs to Better Control Its Growing Paperwork Burden on the Public (1981).

Therefore, many toxic pollution regulations probably prohibit some harmless conduct,[147] but allow other quite harmful activities to proceed.[148]

Finally, a control strategy based on regulation focuses on preventing harm to individuals. It typically does not address harm already incurred by individuals.[149]

In sum, current governmental regulation and enforcement efforts have been ineffective in reducing the costs of hazardous substances to public health and the environment. Regulation and enforcement are imprecise, underfunded, and highly politicized tools. These problems, in conjunction with the failings of the private liability system noted above, demonstrate the need for a new approach to allocating the costs of toxic substances pollution. Other commentators have reached similar conclusions, and advanced a number of proposals.[150] To date, however, little has been accomplished at the federal, state, or international level.[151] This article, and the proposed Model Statute it contains, are intended to stimulate further discussion and activity in this area.

JAPAN'S POLLUTION VICTIM COMPENSATION LAW 1/

(Source: John E. Blodgett. Chapter XIII in U.S. Library of Congress. Congressional Research Service. Compensation for victims of water pollution. Washington, U.S. Govt. Print. Off., 1979. 372 p.)

A considerable amount of experience with compensation for pollution victims has been gained in Japan, which since 1973 has had a substantive Law for Compensation of Pollution-Related Health Damage. The development of compensation law stemmed in part from the Minimata and Niigata disasters plus other episodes, and in part from the evolution of traditional Japanese compensation procedures.

A tradition existed in Japan of "extrajudicial monetary payments" called *mimaikin*, payments "to mollify victim grievances and to restore social harmony." *Mimaikin* had been paid for pollution-type damages as early as the 19th Century. As industrialization proceeded, such payments became more common, and "during the 1950s *mimaikin* were frequently formalized in 'compensation settlement' agreements negotiated by polluters and victims." 2/ Examples would include the payments of Chisso to Minimata Bay fishermen in 1926, 1943, and the 1950s. However, as described in the chapter on Mercury, this form of accommodation broke down during the 1960s, as exemplified by the resort to litigation of some Minimata and Niigata mercury pollution victims.

1/ This section is based on Julian Gresser, "The 1973 Japanese Law for the Compensation of Pollution-Related Health Damage: An Introductory Assessment," *Environment Law Reporter*, v. 5 (December 1975), 50229-50251; Julian Gresser, *et al.*, *The Law for the Compensation of Pollution Related Disease: An Assessment of the First Two Years of Impletation* (Interim Report) (1976), mimeo, 40 p.; and Julian Gresser, "Testimony," in U.S. Congress, House, Committee on Interstate and Foreign Commerce, Subcommittee on Consumer Protection and Finance, *Toxic Substances Control* Act Amendments, hearings on H.R. 9616 and S. 1531, 7 March, 26 April, and 25 July, 1978 (95th Cong., 2nd sess.) Serial No. 95-150 (Washington: U.S. Govt. Print. Off., 1978), pp. 363-367.

2/ 5 ELR 50233.

Basically, the Act works as follows:

Persons suffering from designated diseases who live in officially identified pollution areas are eligible for compensation. The designated diseases include: bronchitis, pulmonary emphysema, chronic bronchitis, Minimata disease (mercury poisoning), itai-itai disease (cadmium poisoning), and chronic arsenic poisoning. The identified pollution areas are of two types: Class I, where air pollution-induced diseases are attributable to multiple causes and sources; and Class II, where diseases are traceable to specific pollutants and sources. Designated illnesses and pollution zones are determined on analysis of correlations between disease and pollution. Epidemiological studies play a crucial role. The level of risk is also factored in. As might be expected, the procedures for designating diseases and pollution zones involve complicated and controversial--and often politically-tinged--debates.

A person having symptoms of a designated disease and living or working in an identified pollution area will be examined by a Health Damage Certification Council, made up of health, legal, and other experts. Upon certification, the victim becomes eligible for compensation representing reimbursement of medical expenses and loss of earnings; assistance is also available to survivors for funeral and other expenses. Compensation for earnings is based on 80% of the average monthly wage. No provision is made for compensating pain and suffering. The designation of victims can give rise to difficulties, particularly when symptoms are not clear-cut or--as is often the case--not fully understood.

Procedures for review of grievences are provided.

The first effort at improving the situation was included in the 1967 Basic Law for Environmental Pollution Control. Besides mandating the establishment of environmental standards, identifying the responsibilities of central and local governments, stipulating the allocation of pollution control costs, and establishing a special Conference on Environmental Control to advise the Prime Minister, the Basic Law directed the "government to adopt all necessary measures for pollution victim relief and the harmonious settlement of disputes." 3/ In 1969 this provision was implemented by the Law for the Relief of Victims of Pollution Disease, which in essence formalized and centralized the *mimaikin* system. A fund was established, supported by tax revenues and voluntary company contributions. A Pollution Victim Review Committee screened victims for eligibility for assistance. This system did not work well: few victims received assistance, and that was usually inadequate; and it depended on the largess of the polluters. This system collapsed when victims in several court cases won decisions establishing their rights to compensation.

Subsequently, on 5 October 1973, a comprehensive pollution victims compensation law was enacted--Law No. 111, Law for Compensation of Pollution-Related Health Damage. This Act established an administrative mechanism by which "designated victims" receive compensation from polluters. Its key innovation was the financing of compensation payments through levies on polluters.

3/ 5 ELR 50237.

Japan also has a workman's compensation system and a national health insurance system. A victim has the option of being compensated under all three programs. Also, even if the victim has received compensation, he can sue the polluter for losses not compensation. Double payments are not permitted.

The total costs of compensation are paid by polluters. Once the number of victims in an area is known and the compensation schedule determined, a budget of compensation needs can easily be computed.

In Class I areas revenues are generated from a graduated emissions charge on stationary sources and a tonnage tax on automobiles and motorbikes. For stationary sources, those located in the designated area at first paid at a rate nine times sources outside the area; in 1976 the Act was amended to rationalize the allocation of these levies. 4/ The tonnage tax is set at a rate to generate 20% of the needed funds. These funds are pooled at the national level and then distributed to provincial governments for payment to victims.

In Class II areas, where a specific source is identifiable, the source pays the full costs, which are distributed to victim groups at the local level.

Since establishment of the program in 1973, the Japanese government has "vigorously implemented the administrative compensation system." At Congressional hearings in July 1978, Professor Gresser of the University of Hawaii and an expert on the Japanese law reported that

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4/ Gresser, "Testimony," p. 366.

200 billion yen--approximately $1 billion--had been collected to compensate some 58,000 victims associated with Class I areas. 5/

As might be expected with a complex and innovative law, experience has revealed both advantages and serious problems. It seems unclear whether the Act has been an effective force for causing polluters to abate discharges. On the plus side, "the Act has introduced a regularity and dispatch into compensation payments which is preferable to the onerous procedures and delays involved in civil litigation or the 1969 relief system." 6/ In particular, it has removed the necessity of each victim to prove the polluter's liability. If the victim has symptoms of a designated illness and lives or works in an area exposing him to pollutants associated with that disease, he can seek designation as a victim eligible for compensation. The victim (or his lawyer) need not go to great expense and effort to seek out the source of the pollution and then prove it caused his illness.

However, the scientific uncertainties associated with relating pollution to disease has generated controversies that some persons suffering pollution-induced disease have not been recognized and that some designated victims would have become ill in any event. In particular, the relationship established in the system between non-specific pulmonary diseases and pollution has been attacked as inappropriate. 7/

At the July 1978 hearing, Professor Gresser summed up experience with the Law for Compensation of Pollution-Related Health Damage as follows:

5/ Ibid., p. 364; Gresser guessed that the $1 billion figure "is inflated" and suggested "perhaps a more realistic amount would be $600 million."

6/ 5 ELR 50244.

7/ Gresser, "Testimony," p. 366.

The general feeling in Japan today is that the compensation system was a necessary political response to the pollution situation that existed in 1973. You had hundreds of people that died of mercury poisoning. A substantial number of people that died of sulfur oxide poisoning in the coastal cities. It galvanized the whole political movement. They had to come up with some demonstration that they were concerned about these problems.

No one is particularly enthusiastic about the Law. Barring a new major pollution-related crisis, the Japanese Government will not expand the present system. No new substances or areas will be designated. There has been some discussion of cancer in relation to pollution. Should cancer be considered. There is no chance in the world that cancer will be designated. Indeed, after this year the Japanese Government's present intention is to begin the process of declassifying currently designated pollution areas.

My strong feeling is the system will not be repealed but will be administratively phased out.

That is it. I should mention that it is an idiosyncrasy of the Japanese approach. There has not been one polluter challenge to the system in court. But that is a characteristic we see across the board. The companies are not litigating environmental problems in Japan but you can imagine how this would be thoroughly litigated if it would be introduced as it presently stands within the United States. 8/

8/ Ibid., p. 367.

STATEMENTS OF 10 INDIVIDUALS WHO LIVE NEAR HAZARDOUS WASTE SITES IN NEW YORK, NEW JERSEY, MASSACHUSETTS, AND TENNESSEE

(Excerpted from: U.S. Congress. Senate. Committee on Labor and Human Resources. Subcommittee on Health and Scientific Research. And Committee on the Judiciary. Health effects of hazardous waste disposal practices, 1980. Joint hearing, 96th Congress, 2d session. Washington, U.S. Govt. Print. Off., 1980. 110 p.)

Senator KENNEDY. * * *

We have as our first witnesses two citizens of Senator Williams' State, the State of New Jersey—which I have developed a new affection for. In Jackson Township, located 30 miles from Trenton, population 25,000, there are 160 residences and wells within 1.5 miles of the 135-acre municipal dump site.

Since 1972, more than 200 million gallons of liquid waste have been dumped there. The dump was closed in 1978. Private well water was used by at least 160 households; more than 600 adults and children were contaminated with extremely dangerous chemicals. Some of them are known to cause cancer.

We would like to start off, if we could, with Mr. McCarthy.

Mr. McCarthy, we first of all express our appreciation to you and all of the witnesses for their presence here today and for their help and assistance to this committee. We know how active they have been in their communities and how many times they have been trying to get focus and attention on the problem, and we want to indicate to all of them that we want to work very closely in seeing how we can fashion and shape meaningful solutions to some of these questions.

It is a problem of enormous dimensions, and we do not minimize it. I think you will find that all of us want to be constructive and helpful in trying to see how we can make sure the existing agencies are going to function and work and how we can best help and assist as a legislative body.

Now, Mr. McCarthy, do you want to tell us a little bit about yourself, how old you are, how many children you have.

Mr. MCCARTHY. Thank you, Senator.

My name is James McCarthy. I am 33 years old, and I am from Jackson Township, N.J. Right now, I reside on Route 571, in a 4-square-mile contaminated zone. I am 1 mile away from the landfill. I have a wife and two children, and I have already lost one child, 9 months of age, to a very rare form of kidney cancer.

In the neighborhood itself, there are 10 known serious kidney ailments, including on a stretch of my road alone, within 8 homes, there are 8 people in 6 of those homes with serious problems; 1 kidney death; 2 kidneys, including my own, which had to be surgically removed; 2 people on dialysis.

In the neighborhood, there are seven to eight known miscarriages; there is another unknown baby death, and I thank you for bringing this "toxic shock syndrome" to our attention. We have thought about it, and we cannot get medical personnel to even look into this type of situation.

We have an abnormally large amount of 6- to 9-year-old females with vaginal problems, which is, from what I am told, unheard of at this stage and this age; numerous eye problems, especially after showering. By the way, we are forced to use this contaminated water for bathing purposes.

Senator **Kennedy**. Let me get this picture a little more clearly. You have eight houses in a row; is that correct?

Mr. **McCarthy**. Yes, sir.

Senator **Kennedy**. Are they a mile or two apart, and could you describe the situation more clearly to us?

Mr. **McCarthy**. These eight homes are on Route 571. We are a very rural, middle-income neighborhood. The houses are on approximately a 1,000-foot stretch of roadway, 1 mile downstream from this landfill.

Senator **Kennedy**. What is the distance covered by all eight of them?

Mr. **McCarthy**. A thousand feet.

Senator **Kennedy**. So they are all clustered, effectively?

Mr. **McCarthy**. Yes, Senator.

Senator **Kennedy**. So in those thousand feet, six of the eight homes there have had serious kidney problems, including two with adults on dialysis, and the third with an 11-year-old girl who has had her kidney removed. And you have had a kidney removed, and your 9-month-old daughter died 4 years ago from a rare tumor. That is six out of the eight households with serious kidney problems.

Don't you think that is quite unusual?

Mr. **McCarthy**. I think it is very abnormal.

Senator **Kennedy**. Well, I know you are not a doctor, but what do you think has been causing the problems?

Mr. **McCarthy**. I have expressed my opinion for the last 19 months. I have tried to get Federal help regarding this and have been unable to do so.

Somebody should look into this situation. We have been unable to get State help, and we have been unable to get Federal help.

Senator **Kennedy**. When the dump was actually being used, did you or your neighbors witness any dumping at night?

Mr. **McCarthy**. The dumping in that neighborhood has occurred over a 6-year period; it is a township-owned landfill. There have been reported instances now. At the time, nobody even gave it a second thought until the township knocked on our door in 1978 and told us our water were polluted.

There have been instances of people recalling trucks going into that landfill at night and driving through the neighborhood with their lights out. This is now becoming known. People are now talking to each other and saying, "I remember this," and "I remember that."

Senator **Kennedy**. Do you know whether they have been taking some of the earth from the dump itself and using it in other sites?

Mr. **McCarthy**. This has made us very upset, Senator. The township of Jackson, under orders from the public works department personnel in the town, was ordered to remove some of the soil, approximately 50 truckloads, and bring it 14 miles to the other side of town and use it for fill material at a recreational site.

* * * * *

Senator **Kennedy**. * * *

Mrs. Benesch.

Now, you live in the Jackson Township, and how close are you to the dumpsite?

Mrs. **Benesch**. About a mile and a half away.

Senator **Kennedy**. How big is your family?

Mrs. **Benesch**. I have a husband and two children. I also had a sister and a niece who lived with me for a year and a half.

Senator **Kennedy**. And when did you first notice the problem with the water?

Mrs. **Benesch**. Well, the first time I ever noticed there was anything wrong was the day they came and gave us the letter saying that the water was possibly contaminated and not to use it for drinking purposes. That was November 8, 1978.

Since then, we have noticed that the water has deteriorated since then. But before that, there was no problem with it.

Senator **Kennedy**. So what did you do when you found out that the water was unsafe?

Mrs. **Benesch**. I got hysterical. I immediately called the township and wanted to know what was in the water. They said they did not know, that they would have to come to our homes and take water samples and test them.

I brought to the township's attention the high incidence of kidney ailments right in my own area. I know I myself had never had any kidney trouble until I moved there. My niece had the same problem.

I asked them, "What are you going to do about it?"

They said, "We will find out. It is probably just going to go away. It is probably not that serious."

Senator **Kennedy**. They told you it would go away?

Mrs. **Benesch**. Yes; they said as fast as it came upon us, it could just float right out.

Senator **Kennedy**. Now, you have had some real health problems with your family, is that correct?

Mrs. **Benesch**. Yes.

Senator **Kennedy**. They started in 1977?

Mrs. **Benesch**. Yes; in 1977, I was taken to the hospital with kidney stones, and a kidney infection. I had a miscarriage in 1977. My niece who lived with me in 1977 has been in and out of the hospital four or five times just in the last year with kidney ailments. She has had all tests done, and they cannot find the cause of the ailment.

I have also had a dog die of kidney disease, and I had a cat die of kidney disease. We had an autopsy done on the cat, and they said that the kidney was completely gone, and they thought the cause of it was some kind of chemical pollution.

Senator **Kennedy**. Do you use the water for bathing?

Mrs. **Benesch**. No; I do not. I do not bathe in it, and my children do not use it either. I take them to my family's.

Senator **Kennedy**. Why not?

Mrs. **Benesch**. Well, we were using it for a while. When we first got the letter, they said just not to use the water for drinking, so we stopped using it for drinking and cooking. We were using it for bathing, and my children and I were breaking out in rashes—but not like a prickly heat type of rash; it was big, open sores all over the body. So I stopped using the water completely for bathing.

Senator **Kennedy**. How do you feel about all this, and the health effects on your family?

Mrs. **Benesch**. Well, the health effects that we have right now, we know about, and we can try to deal with them. But I worry about what kinds of health effects will occur in the future.

Senator **Kennedy**. And what has been your experience when you have talked with governmental agencies?

Mrs. **Benesch**. Nobody has the money to help us. I did talk to one of the members of the township committee and asked him if anything could be done. They said they really were not sure exactly what the problem was yet and how far it had gone.

We knew at the time that there were carcinogenic chemicals in the water. I asked him what would happen to us if, in 25 years, we started dying of cancer, and I was told that we would all be statistics.

Senator **Kennedy**. What is the general climate in the community? You must have talked to your neighbors and friends about the situation.

Mrs. **Benesch**. At first, we were all upset. Then we started getting angry, then we were enraged and fearful. There is no other topic of conversation in the entire area. I had friends over, and for 4 hours, everybody was, "water, water, water."

I mean, it is getting to a point where it is becoming a terrible mental stress, as well as physical.

Senator **Kennedy**. And is this the feeling of the entire community?

Mrs. **Benesch**. Yes, in this little 4-square-mile area.

Senator **Kennedy**. What do you think is the cause of this?

Mrs. **Benesch**. Everybody is just afraid. We are afraid.

* * * * *

Senator **Kennedy**. We will go from New Jersey to Woburn, Mass. This is a 300-acre site in North Woburn, used as a dumpsite over the past 150 years for the tanneries and chemical companies.

There are three major problems—a 35,000-square-foot-pit of dried arsenic, which is uncontained and may become airborne at anytime; lagoons of chromium waste, which are uncontained and may reach into small streams and tributaries; and decaying animal hides, which release hydrogen sulfide gas and methane gas.

Let me say I have personal knowledge from visiting many of those tanneries. When you go into those tanneries, hides are packed—they were for years shipped over from Australia, and in order to be preserved, they were doused in chemicals, shipped over, which would take 3 or 4 or 5 months, and then treated in these tanneries up in the North Woburn area and the Reading area. They use some of the strongest chemicals that you can possibly imagine—people work in those areas and have for years, for generations—and then the surplus hides and chemicals are dumped in these sites, and of course, that and other dumpings have caused a very significant problem.

I will start off with Rev. Bruce Young. I want to welcome our colleague from Massachusetts and thank him for coming here. We have been working with you on some of these areas, but I want to make sure we get a very complete record.

Reverend Young, could you tell us how you first got involved with the Woburn hazardous waste problem?

Reverend **Young**. I first became involved because of the lady to my right, who is a parishioner, Mrs. Anderson. I became informed of the fact that her child was diagnosed with acute lymphocytic leukemia about 8 years ago. As part of my pastoral function, I was asked to drive her and her son to Mass. General for treatment of the leukemia.

* * * * *

Senator KENNEDY. Mrs. Anderson, would you like to proceed?

Mrs. ANDERSON. When my child was diagnosed, I was immediately made known of two cases right around the corner from where I live, also of children with leukemia, and subsequently, other children were diagnosed.

In a half-mile radius, there have been eight children diagnosed with leukemia.

Senator KENNEDY. On this map that you have provided for us, is that the area that is designated—in this area, here?

Mrs. ANDERSON. In the circle, yes.

Senator KENNEDY. And within that area, you found out what?

Mrs. ANDERSON. There are approximately 1,500 people who live in that area. In a small school servicing that area, with a population of approximately 300 children, there were five cases of leukemia.

Senator KENNEDY OK. That is clearly, from a statistical point of view, dramatically unusual; is that what you found out in terms of your own talks with doctors?

Reverend YOUNG. I am pleased to hear you say that, but that was not the case. For 7 years, we were told that the burden of proof was upon us as independent citizens to gather the statistics. The Commonwealth of Massachusetts does not have a cancer or tumor registry bill right now. All our work was done independent of the Commonwealth of Massachusetts. They offered no support, were in fact one of our adversaries in this battle to prove that we had a problem. And the intention going in was just to find the facts—was there indeed a cluster of leukemia in East Woburn, or was there not. It was incumbent upon us to do that work.

I was naive, Senator. I thought that if you thought you had a problem, you made a telephone call, somebody pushed a button on a computer, and some figures came out and they said, "Yes, you have a problem," or "No, you do not."

Well, the closest I got to that was 4 years ago, when that call was made, a computer button was pressed, and they said Woburn has no problem at all in terms of public health, that there are 40 other communities in the Commonwealth of Massachusetts that have higher incidences of cancer. We later found out the computer was in error, or whoever read it did not read it properly, that indeed the city of Woburn has the dubious distinction of having more cancer than any other city in the Commonwealth of Massachusetts—liver, kidney, leukemia.

The Government has not been our friend, and it has been a problem—with some notable exceptions. I think that credit should be given to those people who have assisted us. Kathy Badwar, from your office, has been of great help; Jerry Saleme, from Ed Markey's office; on the local level, Nick Paleologus, in the State. But by and large, the Government is not interested.

Senator KENNEDY. Now, you had to go out and find these cases on your own, is that correct, by doing the surveys within the community?

Reverend YOUNG. Yes.

Senator KENNEDY. And then on the basis of that, relying on your own resources, you were able to develop the statistics which show in that geographical area the very dramatic numbers of leukemia victims and the number of children that have been affected; is that correct?

Reverend YOUNG. What you should be aware of in the coding of that map, those figures in black represent deaths; those colored in green are children that are still living. And the Commonwealth of Massachusetts only goes on mortality, so because those children have not died yet, they are not important in their statistical analysis.

Senator KENNEDY. Now, what does this particular geographical area have in common?

Reverend YOUNG. I will maintain three facts, and then I think it is up to other people to go from there. The facts are these, that there is a cluster of leukemia in East Woburn; that is clear. Another fact is that just to the north—I think it is marked on that map—just to the north of that cluster are figures G and H. Those are two wells, the source of water for that entire area. G and H wells were shut down a little over a year ago because by accident—there had been a spill, and they wanted to check the wells that were in proximity to that dump. So they were testing for something else, and the chart went off the wall in terms of the trichloroethylene. The amount of trichloroethylene there was incredibly high. So therefore, they closed it down. That is fact No. 2. Those wells have been polluted, contaminated. They do not know how long, because they were service for years, since 1964.

Senator SCHWEIKER. When did they find the TCE?

Reverend YOUNG. They found the TCE about a year and a half ago, and the wells were shut down at that point.

Senator SCHWEIKER. Because of the TCE.

Reverend YOUNG. Because of the TCE. However, they do not know how long the TCE has been in the wells, because they never tested for it prior to that. OK. That is fact No. 2. Those wells are contaminated. Fact No. 3 is if you go north on the map about another half-mile or three-quarters of a mile from G and H wells is what we call Industriplex 128. That is an industrial area where all the goodies have been stored for 130 years. And by goodies, I mean the tannery, the chemicals, all that sort of stuff.

Senator KENNEDY. Mrs. Broderick, how long have you lived in Reading, which is just the adjacent community?

Mrs. BRODERICK. Right. Reading is separated from the hazardous waste site by a highway. You cross the highway, and you are in our Reading residential neighborhood.

Senator KENNEDY. Could you tell us a little about how many children you have and how far from the dumpsite you live?

Mrs. BRODERICK. I have four children. We live a quarter to a half mile from the arsenic pit and from the other buried chemicals in Industriplex.

Senator KENNEDY. And how has the dump site affected your life?

Mrs. BRODERICK. Well, about 10 years ago, a developer bought this land, which has been dumped upon for 130 years and began to develop an industrial park. And as he excavated this park, he would hit pockets of animal hides and chemicals, which would release an obnoxious odor into our air.

Senator KENNEDY. And did it have any health effects on you or your family.

Mrs. **Broderick**. Immediate effects, many people felt nauseous, you had headaches, your eyes would burn, you would have difficulty breathing, sleeping, eating—you could not eat, it was so obnoxious.

Senator **Kennedy**. And did some of the women in the neighborhood tell you about difficulty with their pregnancies?

Mrs. **Broderick**. During one 3-year period on my street, out of eight childbearing women, there were 3 stillbirths, and out of these eight women over the past 9 years, four have had miscarriages.

We have three special ed buses, picking up handicapped children. My street is very short. It is about 12 houses on each side.

Senator **Kennedy**. Let me just get that clear. As I understand, it, of 10 women of childbearing age, 7 had miscarriages and 3 stillborns have been born in the neighborhood; is that right?

Mrs. **Broderick**. I think it is more like eight women of childbearing age, four with miscarriages—some have had more than one miscarriage—and three stillbirths.

Senator **Kennedy**. And there are more special ed buses in that area?

Mrs. **Broderick**. On my street every morning, there are three buses coming to pick up children.

Senator **Kennedy**. And why don't you tell us what that means? Special ed is for the retarded, handicapped children?

Mrs. **Broderick**. Handicapped children, with the various kinds of handicaps.

Senator **Kennedy**. So there are more children in that area that are in need of these special education, 1066, programs?

Mrs. **Broderick**. We do not know; nobody has checked. It would be up to us, I suppose, to check it, and then bring it forth, and if the experience of Reverend Young is still valid, that is what we might have to do.

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Reverend **Young**. I am just a parish priest, and now I have gone into all kinds of other aspects. I get a telephone call in the morning from somebody who says, "I am applying for a job in such-and-such an industry. What is your personal opinion? Will I be safe there? Will it be harmful for me to work in that company?"

Somebody else calls up, and it is a mother-in-law who is concerned about whether their children should buy a house in a certain part of town. There is concern.

Senator **Kennedy**. And people cannot move around very easily—they have a home, they have an investment, and the cost of homes in other places has dramatically increased in the period of these past months.

Mrs. Anderson, about your own personal concerns. I think you have a young son, Jimmy.

Mrs. **Anderson**. That is right.

Senator **Kennedy**. Could you share that with us a little bit?

Mrs. **Anderson**. It has been a very difficult 8½ years. It has been a devastating experience for the whole family. I know and I care for other people who have been affected, as I have, with leukemia.

It is very difficult to see children die or relapse, which in the last 6 weeks, a child has died and two have relapsed. We fear for our children, we fear for their children. The neighborhood lives in fear. If there is a sickness, there is real concern; if the child does not bounce back as rapidly as the parents think they should, then they get upset, and rightfully so. There have been two cases of mono diagnosed within a couple of weeks, and those parents are really upset, because the symptoms are similar.

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Senator KENNEDY. * * *

Let us hear from Bumper's Cove, Tenn. This is an old mining community of 600 to 700 people in the mountains of Tennessee, close to Jonesboro, Tenn. The commercial landfill opened in 1972 on the side of a mountain next to the creek. Beginning in 1973, illegal dumping took place there, with trucks turning their lights off and driving through the town at 3 a.m. or 4 a.m., dumping material. The citizens complained of stench, nausea, vomiting, dizziness, rashes, irritated eyes.

In July 1979, heavy rains caused local flooding and overflowing of the dump site, and 8 of the 10 families had to be evacuated.

We are going to ask Skip Foss to tell us a little bit, first of all, where is Bumper's Cove, and tell us how long you have lived there and so on.

Mr. FOSS. Bumper's Cove is situated in the northeastern corner of Tennessee. It is on the Virginia-North Carolina border area. It is what we consider a natural bowl that contains these chemicals.

I personally have lived there for 12 years, and out of that 12 years, the landfill has been in operation up until 1979, for approximately 9 years.

I personally became interested in it early in 1973, approximately May 1973, when we found that 60,000 gallons of orth-dichlorobenzene was trucked from a plant in Abingdon, Va., that had caused a fishkill in the State of Virginia. There were approximately 300,000 gallons that were supposed to be shipped to our landfill, and somehow, only 60,000 got there. But it was enough to contaminate a large portion of the landfill. This is only a small part of the type of chemicals that we have in this landfill.

We have a list of 12 chemicals that were put on the EPA's 129 worst contaminants. These 12 chemicals were being used for dust control on a road leading to this landfill. This road runs alongside of a creek, which is a tributary to the Nolichucky River, which supplies water to the towns of Jonesboro, Greeneville, and Morristown. These are fairly large towns in Tennessee.

Senator KENNEDY. When did they spray these chemicals? How long ago was that?

Mr. FOSS. In 1973.

Senator KENNEDY. But did they know they were dangerous while they were spraying them?

Mr. FOSS. I do not know if they knew they were dangerous, or just did not take the time to find out if they were dangerous.

Senator SCHWEIKER. For what purpose were these chemicals put on the road?

Mr. FOSS. For dust control, to keep down the dust while the trucks ran over the road.

Senator SCHWEIKER. Better to breathe the dust.

Mr. FOSS. That is right. The area that I was talking about is just a giant bowl. Anytime there is dust stirred up or any kind of activity within this bowl, it stays right there. It is just circulated throughout the whole community.

Senator KENNEDY. Now, when did it close down?

Mr. FOSS. It closed down in July 1979.

Senator KENNEDY. And why?

Mr. FOSS. Because the citizens were fed up to their teeth with Government redtape and local redtape, and we just formed a barrier across the road and said, "This is it. You are not going any farther, and you are not taking anything else in."

Senator KENNEDY. What do you mean, you formed a barrier across the road?

Mr. FOSS. Well, citizens of our community completely barricaded the area for 24 hours a day for approximately 3 months.

Senator KENNEDY. So you had a human barricade across the road?

Mr. FOSS. That is right.

Senator KENNEDY. And what would they do—was this to stop the trucks from dumping?

Mr. FOSS. Yes, sir. This was initiated to not allow any other trucks to go into this landfill.

Senator KENNEDY. For 24 hours a day?

Mr. FOSS. For 24 hours a day.

Senator KENNEDY. Did all the citizens respond?

Mr. FOSS. No. There were approximately 150 to 200 citizens.

Senator KENNEDY. They responded, and they kept this 24-hour blockade going. And that was enough to close it down?

Mr. FOSS. Well, initially, it did for a few weeks. Then, we had to go into court to fight for the right-of-way that was going into this area.

There was a 3-ton load limit that they had to cross that had been condemned by the State earlier, in 1976, but they had continued to use this. This helped us in our fight against it. But they took an alternate route which went through a cemetery where the citizens had been buried for 125 or 130 years. And they were hauling these chemicals through a cemetery and across this creek that leads into the river.

Senator KENNEDY. Now, what kind of health hazards did the community experience? You have a daughter, as I understand.

Mr. FOSS. Well, it caused quite a few respiratory problems. On several occasions, at 2 a.m. and 3 a.m., the trucks would go through our community with the lights turned out, and when you would go to find out what was going on, you could hardly breathe. And on one occasion—in fact, on more than one occasion—I had to take my daughter to the doctor. On one particular occasion, I had to give her mouth-to-mouth resuscitation to revive her.

Senator KENNEDY. From the fumes?

Mr. FOSS. Yes.

Senator KENNEDY. Mrs. Turner, how long have you lived there?

Mrs. TURNER. I have lived there approximately since 1974.

Senator KENNEDY. And how close is your home to the dumpsite?

Mrs. TURNER. Our property is adjacent to the landfill.

Senator KENNEDY. And what has been the impact of the dumpsite on your life? What sort of health effects has it had?

Mrs. **Turner**. Very bad health effects. We have suffered many illnesses, myself included. I have two children and two small grandchildren, ages 5 and 6. And we have had daily effects from these things. We have had immediate effects, and then we have had long-term effects.

I have lung damage, respiratory problems. Fifty percent of my community have respiratory problems. When we had this spill in February of this year, I said, "That is it." I could not bear it any longer. So I left.

Senator **Kennedy**. You moved out?

Mrs. **Turner**. I left. I moved out. I now reside——

Senator **Kennedy**. Because of the health dangers to your children and your family?

Mrs. **Turner**. That is correct. I went to Lexington, Ky. I am in that bluegrass section. The pediatrician that saw my little children, a stranger, he looked them over, and he turned around and he said, "I am very worried about these children," and so was I.

So under advice from the children's physician there and from a doctor who hospitalized me, we were advised to stay out of the area.

So we are there temporarily. Our residence is still in Bumper's Cove, Tenn. My son has to stay there, because you cannot all leave. And it has completely divided our family. We suffer all these fears that all these other people have. We are scared about the future as well as the present.

Senator **Kennedy**. Mrs. Turner, do the other mothers in that community share your anxiety and concern?

Mrs. **Turner**. Absolutely. The whole community shares my fears, anxieties, and anger.

Senator **Kennedy**. What happened, Mr. Foss, when you tried to get a hold of the EPA to get some action?

Mr. **Foss**. Well, mainly we got the royal runaround. You had to contact this person, and then he would tell you to contact this other person, and in turn you would come right back around and start where you began.

Finally, after several of the citizens had to be evacuated in 1979, we did get some tests run. But when the water samples were split with EPA and with the State—in fact, I have the reports here with me—the State would come up and say there were no pollutants in these wells and in this area. EPA comes up, and they say that they have found trichloroethylene and toluene within one well—only minute amounts, but as far as we are concerned, there should not be any amounts of any kind in any well within our community.

Senator **Kennedy**. OK. Bloody Run, 80,000 tons of chemical waste deposited in Hyde Park landfill in the thirties, forties, and fifties, which is about four times as much as was actually dumped at Love Canal. And that landfill drains into Bloody Run Creek, which runs through Niagara University and then into the Niagara River.

They have found dioxins, which is the most lethal chemical known, PCB's, myrex, in the rafters of plants in the area, and dioxin levels have been found in the sediment in Niagara University.

Mr. Armagost, could you tell us a little bit about how long you have lived in the Bloody Run Creek region of Niagara Falls, and how big a family you have, and how close you are to the Hyde Park landfill?

Mr. ARMAGOST. I moved into the area in November 1955. I have a family of 10 children. I live about one-quarter of 1 mile from the dump. Bloody Run Creek runs through the corner of my property, less than 150 feet from my house.

Senator KENNEDY. And when were you first aware that there was a problem?

Mr. ARMAGOST. In the early sixties, the fumes would be so bad you would have to stay in the house. The animals and the kids would get in the creek, and the water would burn their feet and would take the hide off of the dog or cat. Some of the cats that had gone in the creek, lost their teeth and died.

When we complained about it, we were told that there was nothing dangerous about it.

Senator KENNEDY. Nothing dangerous about it?

Mr. ARMAGOST. That it was just an odor.

In about the middle of the sixties, I became very concerned about it, because in the late fifties and early sixties, the New York State Power Authority came through and installed a culvert in the creek and Niagara University had put a culvert in. The culvert had restricted the flow of water, and it was damming up, and the creek would get 150 to 200 feet wide, 300 to 400 feet long, and 6 to 8 feet deep.

My boys, along with the neighborhood boys, would go in there in innertubes, fall off into this stuff, and they would just swim around. When the creek was down, and they would get in this stuff, you would have to take their clothes and burn them, because you could not wash it out.

Senator KENNEDY. You could not wash what out?

Mr. ARMAGOST. The material that was running into the creek?

Senator KENNEDY. Would it stain the clothes?

Mr. ARMAGOST. No; it was the odor.

Hooker not only dumped into the landfill; they dumped into Bloody Run Creek. They would back the tank trucks up to the edge of the dump and open them up and dump the material right into the creek.

In the midseventies, Lake Ontario was closed to fishing because of the myrex in it. When Senator Gore had the committee, he made the statement that the myrex in Lake Ontario was directly drained into Bloody Run Creek off the Hyde Park landfill.

Senator KENNEDY. Are you concerned about your grandchildren?

Mr. ARMAGOST. I have 12 living, and most of them have respiratory problems.

Senator KENNEDY. Such as wheezing, asthma, and other kinds of respiratory infections?

Mr. ARMAGOST. Yes, sir.

Senator KENNEDY. I understand you have gone to the emergency room several times; is that right?

Mr. ARMAGOST. Yes, sir. We had to take my oldest grandson to the doctor for adrenaline shots at Children's Hospital.

Senator KENNEDY. How old is he?

Mr. **Armagost**. Five. One little granddaughter, who will be three in September, has been doing this for a couple of years. They would take her to the Children's Hospital, and the veins in her arms would be so small that they would have to shave her head and feed her the medicine intravenously; and tie her down so she would not pull the tubes out.

Senator **Kennedy**. From personal experience, we know that there is asthma in families. But as I understand, what you are talking about is something that has affected a great number of these children and affects a great number of the children in that area; am I correct?

Mr. **Armagost**. Yes, sir.

Senator **Kennedy**. So it is not just something where just a few of the families have children who have asthma or respiratory problems, but as I understand it, it has affected a great many of the children in that particular geographical area.

Mr. **Armagost**. I think this is the only thing that the State health department has admitted to in that area—that there is a respiratory problem. And it was apparently because of a letter from Dr. James Dunlap, concerning our family, to the Niagara County Health Department.

Senator **Kennedy**. Now, I understand that there have been difficulties in a number of the women in having successful pregnancies; is that so?

Mr. **Armagost**. Yes; out of 14 girls that were raised in the area, of 31 pregnancies, there were 8 or 9 miscarriages. I am not sure what the number of respiratory problems is.

Senator **Kennedy**. What has been the response of the governmental agencies?

Mr. **Armagost**. When I first tried to get something done because it was running into the Niagara River, I called the Army Corps of Engineers, and they said that it was not in their territory, and that they could do nothing about it.

I called the DEC, and they got so tired of me calling them that one representative got down on his hands and knees and stuck his lips into that water in that creek and said, "I will show you that there are no contaminants in it." I guess he is still living, but if he is not sick, I hope he is. Whether he consumed any of it or not, I could not say.

Senator **Kennedy**. But he did not take very much of it, though, did he?

Mr. **Armagost**. No, I do not think so.

Senator **Kennedy**. Now, what did the other agencies tell you when you asked for information? They just did not react. You were pretty frustrated by that, weren't you?

Mr. **Armagost**. When the New York State Health Department came in there, as far as I know, they did nothing but a survey. When OSHA was called in, they made an examination, and then they called NIOSH in. NIOSH found two of the plants adjacent, one with dioxin dust, one with PCBs. And about 2 weeks ago, they found another plant, Reef Brothers, that straddles the creek, with PCB's in the rafters and a high concentrate of dioxin in a manhole.

Senator **Kennedy**. What about your own concerns about your grandchildren's future; are you worried about this? And what is the attitude in the community, of the parents, for their children's future? Is there a lot of anxiety, concern, fear?

Mr. **Armagost.** I cannot really say. The cooperation has been nil. The plants in the area became active, and then because of the job losses, I guess they just died down.

We have a university that is less than a one-half mile downstream, that last year had 5,000 students. My home, it is on the windward side of the creek, and I have heard the president of that university say that there was no environmental hazard there.

Senator **Kennedy.** It would certainly take a lot to convince you of that, though?

Mr. **Armagost.** It certainly would.

Senator **Kennedy.** Let us go to Love Canal, where Hooker Chemical dumped waste from the thirties to 1952. In 1953, a school was built on the dump site, and houses began to be built. In 1977, 1978, health hazards first became apparent. The State evacuated those residents living closest to the site.

Although no health hazards have been proven, there has been a lot of suggested evidence resulting from the Quick and Durdy studies. These include high miscarriage rates, high incidence of birth defects, high incidence of nervous disorders, urinary tract problems, high incidence of asthma, incidence of low birth rates, and most recently, chromosomal damage. As a result, additional residents were evacuated.

If we could hear from Phyllis Whitenight. Could you tell us a little bit about yourself? When did you move to the Love Canal zone, and how big a family do you have?

Mrs. **Whitenight.** I have been in the house that I am living in now for 25 years. I have five children. I have had chromosomal damage. I have also had breast cancer.

On my street, we have a total of 15 houses. There have been five cases of breast cancer, one case of bladder cancer, and one throat cancer. And a German shepherd had to be put to sleep last year, because he was full of cancer.

Senator **Kennedy.** Now, let me be sure I understand. Of the 15 houses on the street, over what distance is this?

Mrs. **Whitenight.** They are about 60-foot lots.

Senator **Kennedy.** So they are right next to each other over the distance. And of these 15 houses, six of the women have breast cancer; is that right?

Mrs. **Whitenight.** Yes, there have been six women.

Senator **Kennedy.** And there are two men with cancer; is that correct?

Mrs. **Whitenight.** Yes.

Senator **Kennedy.** And altogether, 7 out of the 15 houses on one block have cancer of one sort or another.

Mrs. **Whitenight.** That is right.

Senator **Kennedy.** And what kind of health hazards have other members of your family had?

Mrs. **Whitenight.** About 2 years ago, we started getting water in our basement for the first time in 23 years. My husband had to come home from work every night to push the water down the drain. And in doing so, he got one of his hands in the water, and he has had a skin problem with his one hand since then that has not gone away. It is like the hand is shrivelled and peeling. He has also had sties and cysts.

My son has had a lot of stomach ailments and throat infections. My older son has also had skin problems and throat infections. And my youngest son has had a terrible skin problem; it has gone away with medicine now, but it is the worst rash I have ever seen.

Senator **Kennedy**. You probably do not have to be a doctor to recognize that out of 15 houses, where there are 6 women with breast cancer and 2 men with cancer, that there is a very serious problem.

Mrs. **Whitenight**. That is what I tried to tell Dr. Axelrod at our first meeting when he had just become health commissioner. He told me that was the national average.

Senator **Kennedy**. He told you that was the national average?

Mrs. **Whitenight**. Yes, and I did not know what to say to that.

Senator **Kennedy**. Well, you know that there is a serious health problem, and all your neighbors and friends could repeat the tragic stories that we have heard here this morning.

When you were one of the participants in the chromosome study, were you told you had normal chromosomes?

Mrs. **Whitenight**. Yes, I was.

Senator **Kennedy**. And were you given an explanation about what the testing meant—how did you find that out?

Mrs. **Whitenight**. The doctor from EPA called us over to the homeowners' office, and we were each taken into one of the rooms and told that we were 2 of the 11—my husband and I both had chromosomal damage—he tried to explain what it meant, but of course, we did not understand it.

Senator **Kennedy**. Were you told anything at all about the test, what it meant?

Mrs. **Whitenight**. He said that it could mean birth defects, miscarriages—I have also had a miscarriage—and cancer, which I have had.

Senator **Kennedy**. What do you think about the way the government has handled the Love Canal situation?

Mrs. **Whitenight**. Terrible, just terrible.

Senator **Kennedy**. And what about the mood in the area now?

Mrs. **Whitenight**. Like the rest of these people, people are so angry, they just do not know where to turn next. Everybody has turned us down in one way or another, from the small local government, right up to President Carter.

Senator **Kennedy**. Mrs. Barbara Quimby, could you tell us how long you have lived in the canal, and do you have any children?

Mrs. **Quimby**. Yes, I was born and raised in the Love Canal area, and so was my husband. I have been there 29 years and my husband, 36.

I lived right on the canal itself. My parents were one of the first to be permanently relocated. We bought my in-laws' house, and since then we found out that his sister who died in the house—he was too little to remember—died of a rare disease called Banti's anemia. It is a very rare blood disease, and it can be caused by the combination of two chemicals, toluene and benzene. I have readings concerning this disease in my home.

My 3-year old has respiratory problems that cannot be explained. She has been rushed to the hospital four times in 3 years; she just stops breathing for no reason.

My 8-year-old daughter, Brandy, has three congenital birth defects. She is mentally retarded; she has a congenital eye and teeth defect. She has had surgery on both. She was born with only one-third the muscles required in the eyes. She does not have full vision. Numerous, numerous problems which have never been explained.

Under normal genetic testing, the doctors were baffled. The genetic doctors could not understand why they could not find some kind of chromosome imbalance.

When EPA did the study, I learned first of all through a press release, that the study was 30-percent greater risk than what they thought—it was just astounding. I had to learn it first through the press before I was even told, knowing I was one of those people, so first of all, I had that on my mind.

I was called to the Love Canal Homeowners' Office and taken upstairs, and there was a doctor from EPA there. He handed me a letter. I read it, and the letter was so shocking, it was so scary, and I said, "What does this mean?"

He said, "Well, this means 30 percent higher risk of cancer. This means 30 percent higher risk of miscarriage, birth defects to children. And also, we found some damage to your white blood cells." Well, I have suffered all my life with respiratory problems—pneumonia, pleurisy, bronchitis, just constant—female problems, surgery as early as 16, female surgeries. I was shocked and surprised, yet in a way, it was finally an answer. Why did the regular doctors never find anything? Why don't I have any resistance? Why do I have Brandy? And when they do this more extensive testing, which we need, we are finding results. But it does not help the residents, no matter what they find. The nerve conduction came back, and it was really bad. And we are still there.

Dioxin was found. We are still there. It is the deadliest chemical known to man. The two public schools are closed in our community. We do not even have a school in our community.

We are now living in a one-room motel—two children, my husband and I. We have cabin fever already. The children wonder, "Where is our swingset? Where are our bicycles? Why can't we bring the dog here?" We just cannot take much more of it. We are at the breaking point.

Our leader, our association president is here, who has pounded the pavement for these people for 2 years, and the President thinks if he sees her, it would be a waste of his time.

Now, when you get that kind of reaction, where do we go, what do we do?

I was also a naive housewife. I thought that you called EPA, and they handled it; the Health Commissioner would handle an outbreak of smallpox, and he is certainly not going to keep us there with dioxin. I just cannot believe why we always have to go door to door and beg. The help should be there. These are what the people are in power for. If one housewife can do all of this, I cannot believe that the people in power are doing nothing, and we are still there.

I am sick of being a guinea pig; I want out. Test me later, but my God, get me out now, and my kids.

I could have passed the chromosome damage down to my children. They do not know. I have to live with that. It is just so scary, the fear that you have to live with. No normalcy. You do not watch TV, you do not go to a movie. You have no social life. I mean, your relatives will not come to your home. You cannot have birthday parties for your children and invite any children outside the area because their mothers will not let them come there.

It is just horrible. It is like 2 years out of our lives are gone, and we live and breathe this every day. I just want someone to do something and help us so we can end this tragedy and learn how to clean it up, and set the precedent, because Love Canal is not last, it is the first of many. And they should set the precedent, and they should find out how are we going to help these people. It is happening all over the country.

Legal Remedies for Toxics Victims Begin Taking Shape

Bills that provide redress for victims of exposure to hazardous materials are gaining higher priority on the legislative agenda

Lois R. Ember, C&EN Washington

Blink and it's 1978. A film clip shows New York Gov. Hugh Carey announcing to the residents of the Love Canal area of Niagara Falls that the state will purchase those homes closest to the violated chemical dump. Blink again and it's 1983. This film clip shows the tense faces of the residents of the dioxin-tainted town of Times Beach, Mo., peering through a glass door, straining to hear Environmental Protection Agency Administrator Anne M. Burford announce to the press that Superfund money will be used to buy out the town—all homes and businesses.

Though separated by time, both these environmental disasters have elements in common beyond the presence of highly toxic 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. In fits and starts, both are expanding the frontiers of medical science and legal theory. Both are forcing society to institutionalize a balance between the benefits of industrialization and the risks of serious harm. Love Canal already has prompted Congress to pass remedial cleanup legislation, the 1980 Comprehensive Environmental Response, Compensation & Liability Act—or Superfund law—to remedy harm to natural resources. Coming on the heels of a string of toxic insults, Times Beach may be the fuse that triggers Congressional action to compensate victims for personal injuries relating to exposure to hazardous substances.

The issue—toxic torts, or damage claims for these personal injuries—was contentious enough in 1980 to be compromised out of Superfund legislation. It remains equally prickly today. The policies and their constituencies guarantee that. And though it waxes and wanes in the public's attention and on the political agenda, it does so against a backdrop of fierce determination on the part of a few members of Congress to correct what in 1980 Sen. George J. Mitchell (D.-Me.) called an irrational balance of placing things above people.

Proposed legislation could run into stiff opposition

* Reproduced with the permission of the American Chemical Society from Chemical and Engineering News, v. 60, Mar. 28, 1982: 11-20.

A legal lexicon

Common law. Judge-made law. The evolving body of case law and legal theory derived from English jurisprudence, and based on custom. It is used to resolve disputes in the absence of applicable statutory law.

Common law of tort. A tort is a private or civil wrong or injury whose remedy is an action (suit) for damages in a state court. A toxic tort is a wrong or injury inflicted on an individual by a hazardous, or toxic, substance; remedy for personal injury or property damage is usually an action based on the doctrines of negligence, or strict liability.

Discovery rule. Under this principle the statute of limitations for bringing suit starts when the plaintiff might "reasonably be expected" to have become aware of, or to have discovered, his injury.

Joint and several liability. Plaintiff need not identify all possible contributing defendants to bring action. Instead, the plaintiff can sue any of the alleged defendants for the entire amount of his damages. A defendant who ends up paying may, in some states, proceed against the other contributors by using a "right of contribution" to try to recover a share of the payment.

Negligence. Actions based on this doctrine focus on the conduct of the activity. Plaintiff must show that the defendant knew or should have known the risk, that the defendant breached a standard of due care, and that the negligent conduct was the direct cause of actual loss or damage suffered by the plaintiff.

Rebuttable presumption. This concept relieves the plaintiff from establishing a direct link between his or her injury and the alleged cause or source of harm by presuming that the preponderance of facts establishes that link. The burden then shifts to the defendant, who must rebut the presumption that he or she should be liable for plaintiff's damages. If allowed, this concept would permit such indirect scientific evidence as epidemiologic and clinical studies, and animal data to be offered to establish the presumption.

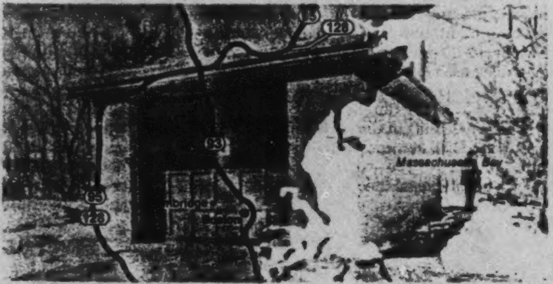
Rules of joinder. Liberalization of these rules would allow plaintiffs with similar cases to argue such issues as causation and liability jointly, but separate trials would be held to determine individual damages.

Strict liability. This doctrine applies when an activity involving a risk is considered abnormally hazardous. The standard of care is so high that a defendant's action is determined to be unreasonable if any injury or harm occurs. The plaintiff does not have to prove negligent conduct on the part of the defendant. But the plaintiff still must show that the defendant's action was the proximate cause of his or her harm.

Toxic tort case may be at frontier of legal doctrine

Woburn, Mass., a 13-square-mile city with a middle-class population of 36,000, is situated in the heartland of the state's recent high-technology boom. Woburn has always been an industrial town. Tanneries once were scattered throughout the town and greenhouses flowered. Now both of these 19th century industries have nearly disappeared, only to be replaced by other manufacturing concerns. For instance, the Cryovac division of W. R. Grace, which manufactures packaging equipment for the food industry, began operations in Woburn in 1960.

The legacy of the city's industrialization can be read in the contaminated Aberjona River watershed, which is a drinking-water source for Woburn, and in the adverse health effects manifested by some of the town's residents. At least that's the contention of plaintiffs in a lawsuit filed last May.



The 34 plaintiffs, comprising eight families, all live in east Woburn. From the mid-1960s until May 1979, their source of drinking water was city wells G and H, which tapped the aquifer underlying their section of town. In May 1979, the Massachusetts Department of Environmental Quality Engineering (DEQE) received reports that "midnight dumpers" were disposing of 55-gal drums on an empty lot near the Aberjona River owned by the Metropolitan Boston Transit Authority. Upon investigation, DEQE found drums containing polyurethane foam. This finding prompted DEQE to test the two wells closest to the dump site for organic chemicals. Those wells, G and H, were found to contain high levels of trichloroethylene (as high as 400 ppb, for example), tetrachloroethylene, 1,1,1-trichloroethane, *trans*-1,2-dichloroethane, and trace amounts of benzene (less than 10 ppb) and chloroform (1 to 12 ppb).

The well contamination has never been linked to the drums, which mysteriously disappeared from the lot. But the pollution was so great that DEQE closed the wells immediately.

Today, each of the eight families has a member who has leukemia or who has died from that cancer. The families contend that the contaminants in the well water are the source of the known leukemias, and may place those presfrom the business and industrial communities, especially the petrochemical and insurance industries; trial lawyers; environmental and consumer groups; and labor unions. Opposition will depend on whose ox is gored. That, of course, hinges on how the problem is defined, and how the compensation regime is structured. Exposure, for instance, could be confined to contaminants in the workplace, or broadened to exclude the workplace but embrace the general environment, which, in turn, could be narrowed to only those exposures to toxic materials from hazardous waste sites. At the outer limits, legislation could be written so broadly that universal exposure to toxic substances both in occupational and nonoccupational settings would be covered.

Obviously as coverage widens, more potential victims are caught in the net, and the larger the safety net or compensation scheme has to be. Such a scheme could take the form of an administrative fund fed by taxes on industry and/or general revenues. Or, the plan also could allow victims to bring court actions to redress the tort, or wrongdoing.

As usually envisioned, the fund is fairly easy to enter—evidentiary burdens on the victims are eased—transactional costs (lawyers' fees) are low, and compensation is rapid but limited. Tort lawsuits, on the other hand, usually are drawn out and require substantial expertise. This is costly, but the awards are likely to be greater.

The concept of a compensation fund is controversial in part because it conjures up troubled visions of another black lung debacle (the scheme to compensate coal miners for pneumoconiosis). It raises the hackles of industry whose members label it a "national no-fault slush fund" and a device to "finance tort litigation." Occidental Petroleum's vice president for health, environment, and safety Frank B. Friedman calls it a thinly disguised "national health program—an off-budget financing scheme paid for by one or two industries."

Sierra Club lobbyist Blakeman A. Early recognizes the pitfalls. "The problem is to design a fund that, on the one hand, seeks to provide for those genuinely in need but, on the other hand, doesn't create a system that can be so abused that it bankrupts the government."

Emotional rhetoric aside, the complexity of the issues has sent business and industry, Congress and the Administration into a frenzy of activity. A high-powered Chemical Manufacturers Association committee, whose members are drawn from some of the largest companies, has been studying the issue for months, with no consensus policy statement in sight. The American Bar Association has an ad hoc committee examining tort law reform. Several Congressional members are busy reworking legislation offered last year for reintroduction in this Congress. And the Administration has launched an interagency study, spearheaded by the Office of Management & Budget.

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ently symptom-free at increased risk for contracting cancer in the future.

From hydrogeologic studies, the plaintiffs claim that plumes of contamination are traceable to W. R. Grace's Cryovac division and to the John J. Riley Co., a tannery now owned by Beatrice Foods. They name Grace, Beatrice Foods, and other undisclosed companies as defendants in their complaint, which they filed last May in Federal District Court in Boston.

The issues raised by the plaintiffs' Massachusetts lawyers appear to be so novel that the lawyers have sought and are now receiving the legal services of the Washington, D.C., public interest law firm, Trial Lawyers for Public Justice.

Anthony Z. Roisman, executive director of Trial Lawyers who headed up the Carter Justice Department's hazardous waste section, says his law firm "uses plaintiffs' trial litigation as the mechanism for [affecting] public interest issues." The Woburn case is a classic example of "the sort of work this firm is set up to do," he says. It requires substantive expertise, and involves legal issues that today are "not generally accepted black letter tort law," he explains.

According to Roisman, the case would extend the frontiers of tort law in two ways should a judge or jury rule in favor of the plaintiffs. First, it would extend the risk recovery theory to general hazardous waste exposure. Roisman and his colleagues will argue that the exposure to chemicals in the well water caused an immediate adverse impact, but one that might not be overtly obvious for decades. At issue is whether the plaintiffs "should be entitled to recover for that increased risk" now rather than much later when the illness becomes apparent, Roisman explains.

The second argument will allude to the concept of chemical synergism or, at least, that there is a strong probability that "one of the factors causing the leukemia was the exposure to these chemicals," Roisman says. The court will be asked to answer this question: If one of the factors producing the cancer was exposure to chemicals that can be linked to one of the defendants, is that recoverable under the theory of joint and several liability? That theory holds that any of several contributors to a harm can be held fully liable for the harm.

Mark Stoler, an assistant counsel with W. R. Grace, says the only novel issue in the case "is that we have plaintiffs who are alleging that their injuries—leukemia—are linked to a material that's found in the wells in Woburn. As far as we can tell there is no evidence that trichloroethylene causes leukemia and, furthermore, we are not connected with that contamination." The Environmental Protection Agency estimates that the concentration of trichloroethylene in the aquifer amounts to about 10,000 barrels. Stoler says that Grace "purchased a total of four drums of the solvent in 22 years."

In short, Stoler says, there is no merit to the case. Yet Grace's motion to dismiss the case was rejected by the federal court, and the case is expected to be tried in 1984.

On the broader issue of toxic torts, Stoler says: "Legislation that would encourage or allow more lawsuits to be brought of the nature [of the Woburn case] would lead to an unfortunate misuse of everybody's resources." Perhaps. But many plaintiffs and their attorneys seem to disagree. Roisman says there are about a dozen Woburn-type cases being litigated today, and he thinks that "in a year or two there will be hundreds of them."

From the slow pace of CMA's deliberations and the Administration's target date of December for completion of its broad-ranging study, these groups obviously expect the debate to carry over to next year. They may be miscalculating. Another indictment of toxic tort law, another Manville bankruptcy-asbestos-type situation, or another Times Beach could set victim compensation legislation sailing through Congress.

The issue has broad popular appeal, nourished by statements from prestigious lawyers who declare that "innocent-bystander" victims have inadequate avenues of redress open to them. To correct that, they argue for a legislative fix and changes to state tort laws to make it easier for victims to be recompensed for diseases relating to exposure to hazardous substances.

These exposures are the result of the post-World War II industrial boom that wrought many benefits, and some untoward health effects. Common (or judge-made) law and statutory law have evolved to correct social problems vastly different from toxic torts. Compensation mechanisms developed under the law "have been based on a simple cause-and-effect paradigm that doesn't fit scientific reality," says Sheldon Samuels, director of health in AFL-CIO's Industrial Union Department.

Bringing science into the courtroom is difficult and tricky. Medical science, especially, deals in shades of gray. Legal dicta are absolutely black or white. The two are "uneasy partners," writes Jeffrey Trauberman, director of the Environmental Law Institute's (ELI) toxic substances program, in the recently released ELI publication "Statutory Reform of 'Toxic Torts.' " "Proof of environmentally caused injuries almost always requires the introduction of evidence on the 'frontiers of scientific knowledge,' " he notes.

But leading-edge science—epidemiology, the statistical assessment of probable cause of disease; clinical data; and results from animal studies—often is dismissed by the courts as being too imprecise, or irrelevant to the specific toxic tort case being tried. Yet it is just that type of input that a victim must marshall to prove causation—that his injury was caused by exposure to a hazardous substance. This is particularly true with diseases such as cancer, which may have several but interacting causative factors, and a long time-to-tumor period. It is especially difficult when the source of exposure is a hazardous dump, with its caldron of varied chemicals.

Often the long latency period is an absolute barrier to judicial remedy. Some state courts have statutes of limitations that begin running from the time of exposure, and bar suits for damages two to seven years after that event. Cancer in victims or birth defects in their children come too late to meet limits that were designed for accidents or acute illnesses.

Changes to the limitation rule, which some states already have made, cause few problems. But shifting the burden of proof of causation from the victims' shoulders onto those of the defendants as some proposals would do, offends legal conservatives, disturbs defendants (industry), and concerns social commentators who worry about balancing rights. Yet the structure of the funding mechanism, and apportionment of liability may even be more problematical issues than causation.

The issue of liability is tied to potential damage claims—an unknown, or at least an unpublished, figure at this time. That uncertainty, industry claims, hampers business planning, affects credit ratings, and may prevent insuring against risk.

Andre Maisonpierre, senior vice president of the Alliance of American Insurers, says that insurance companies will underwrite policies only for risks that can be measured and spread. Because these conditions can't be met in the toxic tort arena, he says companies producing chemicals "will have a difficult time getting insurance. The large companies will be forced to turn to self-insurance [as Du Pont has already], and the small companies probably will go without."

Balanced against these business concerns are the legal rights of individuals to seek compensation for harm in the courts or through administrative funds. Those rights have been recognized in several proposals. One would alter state tort law to ease the burdens of common law recovery; another would expand Superfund coverage to include out-of-pocket medical expenses for personal injuries; yet another would create an administrative fund separate from Superfund; and still another would establish a federal cause of action, in essence duplicating state tort systems.

Legislation incorporating elements of the four proposals for improving the odds for getting compensation are being considered, or drafted. Rep. John J. LaFalce (D.-N.Y.) soon will introduce his victim compensation bill. Senators Robert T. Stafford (R.-Vt.) and George J. Mitchell (D.-Me.) are drafting theirs. Rep. James J. Florio (D.-N.J.) and Rep. Edward J. Markey (D.-Mass.) have introduced their bill. Rep. Albert Gore Jr. (D.-Tenn.) is studying the victim-recovery issue, and Rep. Donald Albosta (D.-Mich.) has asked the Congressional Research Service to examine the legal issues and their ramifications. An Albosta aide says the Congressman may introduce a bill later in the year.

According to Dow's director of legislative and regulatory affairs Leslie F. Nute, the driving forces behind this rush to legislate victim recovery are "the vast proliferation of toxic substances litigation, and the perception that there are scores of victims and [that] the current legal system doesn't work."

Nute's assessment, however, overlooks other pressures, the most recent one being a report on managing hazardous waste from the Office of Technology Assessment. In it, OTA says that up to 275 million metric tons of hazardous waste under federal and state regulation are generated annually. Up to 80% of this waste is deposited on land, a practice fraught with problems even when the best practices are enforced. But OTA says that current hazardous waste management regulations are not instilling the best procedures and are failing to detect, prevent, or control releases of toxic substances into the environment. OTA cautions, "Long-term health effects from exposure to hazardous waste are uncertain, but they may be serious."

To prevent future health hazards, the technology assessment office calls for a strengthening of the Resource Conservation & Recovery Act and Superfund regulations. And it endorses a change in the Superfund fee from a front-end levy on chemical feedstocks to a tail-end tax on hazardous waste generated. Although more difficult to collect than the feedstock tax, the waste generator tax is more equitable. Part of the tax could be dedicated to compensating victims injured by chemicals from violated landfills, says Joel S. Hirschhorn, OTA study project director.

The chemical and petroleum industries may find an administrative fund supported by this tail-end tax more palatable than the current Superfund and most of the other administrative funds so far proposed. The ELI proposal, for instance, initially keeps the Superfund taxing mechanism, which phases out over time as a degree-of-hazard tax on the tobacco industry and asbestos manufacturers is phased in.

As influential as the OTA report may turn out to be, Congress usually responds with greater alacrity to highly publicized tragedies such as Love Canal and Times Beach than to well thought out studies. Though Love Canal has receded to a prominent place in environmental history, it and the saga of Times Beach are still playing out, but not in a vacuum. Other past toxic disasters are still unresolved and remain fresh in the memories and fears of the affected individuals.

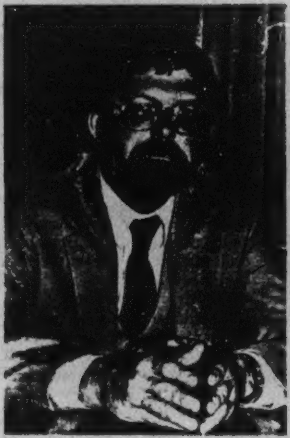
Still other toxic torts are unfolding:

- In Michigan, bags of cattle feed were accidentally mixed with fire retardant polybrominated biphenyls (PBBs), forcing the slaughter of thousands of cows. Today, every resident of the state is contaminated by the chemical.
- To fight a jungle war, the U.S. sprayed the herbicide agent orange over large tracts of Vietnam. Veterans of that war now are fighting for compensation for illnesses they claim are the result of contact with dioxin, a contaminant of the defoliant.
- Long Island's 2.5 million population tapped shallow aquifers for drinking water and household purposes. In two of the island's counties, 25 community wells were closed because they were fouled by trichloroethylene, a potential carcinogen used to clean septic tanks, and by pesticides and landfill leachate.
- A company applied a chemical to a tampon to make it highly absorbent, and hundreds of women came down with toxic shock syndrome. Some died.
- Hundreds of thousands of workers, many working in shipyards during World War II, were exposed to the mineral asbestos. They came down with asbestosis and cancer, and sought workers' compensation. Financial relief was inadequate or not forthcoming from the employer-contributed, state-run fund, so workers turned to the courts and product liability law for relief.

The asbestos case is both instructive and unique. Instructive because it melds two—workers' compensation and product liability—of the three aspects of toxic torts. The third element is environmental harm and third-party injury from hazardous substances in general, and hazardous wastes from disposal sites in particular. It is unique because the population affected, and the cause-and-effect relationship between asbestos and diseases are well defined, unlike most cases of toxic torts.

The asbestos problem has assumed a high political profile because of the glare of publicity garnered by Manville Corp., the leading U.S. producer of the mineral. This financially solvent company has taken shelter from litigation by filing for Chapter 11 bankruptcy. Because of its filing, all 16,500 private liability suits against it (and most of the thousands of suits against other manufacturers) have been placed on hold, at least temporarily. Manville claims the number of its lawsuits could leapfrog to 52,000 and cost the firm $2 billion.

Rep. LaFalce (left) soon will introduce his victim compensation bill; Senators Mitchell (center) and Stafford currently are drafting theirs



Government Research Corp. analyst Outen (left) studies victim compensation policy issues; Dow's Kuszaj (right) and Nute say that a new compensation fund and changes to state tort laws may not be necessary

C&EN staff photo

The extent to which ill-(or dead) asbestos workers are viewed as unknowing, unwitting victims who are now being trifled with by a heartless industrial giant, is the degree of outrage that may translate into Congressional action. That action could take several forms. One could be the federally standardized product liability bill introduced by Sen. Robert W. Kasten Jr. (R.-Wis.) and strongly supported by industry because it limits liability. Others could be federalization of workers' compensation, or a broadly written compensation scheme to redress injuries from exposure to toxic materials in the workplace or general environment.

Though chemical company officials view the asbestos problem as unique and deserving of legislative remedy, they also recognize—and fear—that issues such as asbestos, agent orange, and dioxin at Love Canal or Times Beach cross feed each other. Ronald B. Outen, author with Dale Lawson of a Government Research Corp. (GRC) study on the public policy issues of victim compensation, says, "The political interactions are such that as one becomes notorious, it tends to draw attention to the others, too."

The spotlight could suddenly shift from asbestos to hazardous chemicals, especially those oozing from waste dumps. Yet the chemical industry argues that available data make the connection between these chemicals and ill health tenuous, except in a very few special cases.

Before industry hides behind the shield of scientific uncertainty, it ought to listen to the warning of Stafford, the powerful chairman of the Senate Environment & Public Works Committee. In a speech before the National Agricultural Chemicals Association, Stafford said, "The single category of pollution that [the public fears] most is hazardous waste and toxic chemicals." Though it might be appealing economically for industry to shift the costs of injury to the victim, he warned: "Don't do it." His words are likely to be heeded both because of his control over environmental matters in the Senate, and because he will introduce a victim-compensation bill and hold hearings on it this year.

Adding to the drive behind this rush to drop bills in the hopper are two recent legal studies. One, mandated by the Superfund law, set up a panel of 12 prestigious lawyers who collectively became known as the 301e (Superfund) study group. Last September, the group released its report, which concluded that tort law remedies available to victims of hazardous waste insults "are inadequate in view of the substantial number of claims that may arise, and the factual and legal complexities that will be involved in their ligitation."

The second report by the Environmental Law Institute, echoing the Superfund study group, finds that "mounting evidence suggests that the legal liability system does not provide a meaningful forum for the redress of privately incurred hazardous substances injuries." This study is actually a model state law that could easily be converted to a federal statute. It offers solutions to correct the "inequitable consequences [of current] cost allocations and burdens of proof" that, it contends, make the least able in society bear the risks and the costs of hazardous chemicals.

Both legal studies—and all of the compensation bills to be introduced—offer injured individuals two avenues of relief: a no-fault administrative fund and access to the state courts. The ELI scheme forces the victim to elect one of the avenues; the Superfund study does not. Both legal schemes ease procedural and evidentiary barriers for the plantiff, and both require that the plaintiff reimburse the fund. The ELI model, however, would include economic relief for toxics injuries sustained in the workplace and nonoccupational environment, thus potentially expanding industry's liability.

All interested parties expect the two legal studies to structure the upcoming debate, which may begin this fall and is expected to be long and contentious. Anthony Z. Roisman, executive director of Trial Lawyers for Public Justice, a Washington, D.C.-based public law firm, says the Superfund study "highlights some legitimate concerns and proposes some innovative and useful solutions." Voicing the sentiments of many in business, however, is James M. Kuszaj, a scientifically trained lawyer in Dow Chemical's government relations office. He says the Superfund study "sort of assumes the problem, and then assumes a solution." Occidental Petroleum's Friedman claims the ELI study is similarily flawed. He says, "It required the assumption that there was a problem, and drafting the model state statute then became the solution."

Refashioned into a question, Kuszaj and Friedman's comments become industry's rallying cry: Is the compensation regime a solution in search of a problem? "That's a politically neat phrase," comments a Senate staffer, "but one that distracts attention from the problem."

Distraction or not, the rallying cry goes to the heart of industry's concern: the size of the potential liability problem. That potential is difficult to gauge, as the Superfund study group recognized.

After much soul-searching and research, the Superfund panel concluded that scientific uncertainties make it nearly impossible to determine the number of persons at risk from exposure to toxic waste. But the panel added: "Experience with occupational exposures to hazardous chemicals and with such substances as asbestos, agent orange, Kepone, PCB, PBB, coal dust, and DES indicates a substantial possibility of large numbers of latent injuries and future claims." That is a possibility that could result in a massive assault on the tort system.

The size of the liability depends, of course, on whether the problem is defined as a workplace exposure, a hazardous waste site exposure, or a general environmental exposure. "But in none of these areas do I think there are scores of victims," says Dow's Nute. Though he quickly qualifies that statement: "The only exception is the asbestos case."

Says Nute: "Dow asks, 'If there is evidence of [massive numbers of victims], where is it?' " CMA, a chemical industry trade association, asks the same question.

To answer it, CMA has joined in a lawsuit with the Environmental Defense Fund to prod the federal government into conducting the health-assessment studies at hazardous waste sites it was mandated to do under Superfund. The suit asks that the Department of Health & Human Services and the Environmental Protection Agency begin to collect the data needed to define the scope of health dangers from dump sites and to set up the health registries called for by law.

In addition, CMA has just contracted with Universities Associated for Research & Education in Pathology. The independent research consortium will conduct a feasibility study that will be used by the association to gather the data needed for its own definition of the size and nature of health problems at hazardous waste sites. UAREP's study is expected to be completed in two months. Then CMA will take another six to eight months to complete its own effort to answer the question: Are there so many problems that a victim-compensation system is needed?

A December 1982 letter from Dow to Commerce's Office of Business Liaison would indicate that the company fears the question will be answered by Congress in the affirmative. In the letter, Dow says its highest legislative priority is defeat of any bill that would create "a federal 'toxic tort' law." Such a law, Dow claims, "would make American industry vulnerable to claims by anyone alleging exposure" to chemicals.

Dow and other chemical firms also pleaded their case before the Office of Management & Budget, where they were initially successful. Early this year, they had convinced OMB that victim-recovery bills would be costly and burdensome to industry.

OMB then tried to stall the momentum behind a push for a victim-compensation bill by melding the issue to product liability legislation. The general theory behind that ploy, says GRC policy analyst Outen, "is that the broader and more comprehensive the proposal, the longer it will take to get consensus on it." Also, melding the two issues dilutes Stafford's control over a victim-compensation bill.

On the objections of the departments of Commerce, Labor, and Justice, which saw the issues as distinct and argued for two separate bills, OMB dropped its plan. Instead, it is coordinating a six-agency effort to identify the scope of existing and anticipated harm attributable to exposure to toxic substances, and the economic ramifications of existing and proposed compensation schemes. Not to be overlooked, says Outen, is that any scheme that "establishes rebuttable presumptions of causality relating to cancer" will affect the federal cancer policy, which is now being revised.

The debate, at least publicly, has moved beyond the question of the ripeness of the problem for a legislative fix. EPA files now document the history of inappropriate disposal of hazardous wastes, and the more diligently EPA searches, the more it finds. Also, there are a number of cases in which people have suffered genuine economic and material harm and perhaps even medical problems. Love Canal and DDT contamination of the residents of Triana, Ala., come readily to mind. And, as Sen. Stafford has said, there is a growing public concern about hazardous chemicals.

Comments Environmental Defense Fund attorney Khristine L. Hall: "I, as most environmentalists do, reject the notion that we have to wait until the 11th hour before we move on a problem, until we have the bodies piled up in the streets. I think there is enough evidence to indicate that this will be a problem, that the legal apparatus is not working now, and that we ought to do something about it."

Her colleague, Sierra Club's Early, points to the Manville asbestos case "as a situation that makes a very compelling case for the need to create new institutional mechanisms for responding to what are very new problems."

Workers' compensation is only a remedy for occupational-related illness, and even then it often excludes individuals who have contracted chronic or long-latency diseases. Common-law doctrines of negligence and strict liability (that a defendant breached a standard of due care, or was involved in an ultrahazardous activity), and the problem of apportioning liability among several possible defendants are nearly insurmountable barriers to victims seeking recovery for personal injury and other losses in state courts. So is the exercise of proving causation, or that a defendant's conduct or chemicals seeping from a dump are the direct cause of a victim's injury.

Changes to state tort law can ease the victim's burdens, Early admits. But with no or little income, "how does the victim survive during the litigation process?" he asks. Logic says compensation from an administrative fund.

That raises industry's fears of the use of the fund to finance tort litigation. Superfund study panel member, George C. Freeman Jr., partner in the law firm of Hunton & Williams, would have solved that problem by forcing the victim to seek administrative or tort system remedy, but not both. He notes that existing systems—medicare, medicaid, social security, welfare—can provide for the victims' medical and living expenses, if they choose to litigate. But that shifts the financial burden from the alleged wrongdoers to the general public.

On the election issue and on other matters, Freeman, who is sympathetic to business concerns, was in the minority. The Superfund panel, for instance, called for a no-fault administrative plan funded by taxes on the oil and chemical industries and by a surcharge on hazardous waste disposal. This fund could be tapped by victims to cover all medical expenses and a portion of lost wages. Freeman, however, would have the plan funded from general revenues, at least initially, because the effects of a tax on industry are not known. "I feared that the competitive effects, particularly on the chemical industry, were not known, and absent that special knowledge," the tax might not be in the public interest, he argues.

The Superfund panel refused to recommend the administrative fund as the sole, or exclusive, remedy available to victims—a controversial decision. Instead it also would permit fund claimants to bring private actions for damages in state courts.

If it has to accept a compensation fund, industry would prefer it to be exclusive and "very tightly structured." Exclusivity would shield industry from large liability.

The panel also recognized the substantive and procedural barriers faced by private litigants, and suggested changes to tort law that would make it easier for victims to recover damages in state courts. For example, it called on states to rule that the statute of limitations in a hazardous substance case begins running when the plaintiff first discovers the injury or illness—the so-called discovery rule. States also should institute liberal joinder rules for plaintiffs with similar claims so that complex issues of causation and liability can be heard once. Then, separate trials can be held to determine individual damages.

In addition, the Superfund panel called for the adoption of state rules that hold defendants jointly and severally liable for injury or loss. By accepting this standard, plaintiffs would not have to apportion liability among several contributors, something that is nearly impossible to do in hazardous waste cases. Finally, the panel called on the states to adopt causes of action that apply strict liability to hazardous waste activities.

In his toxics victim-compensation bill, soon to be introduced, Rep. LaFalce adopts a nonexclusive, no-fault administrative fund, similar to that designed by the Superfund panel. This fund is administered by a board that certifies victims' claims for all medical expenses and a substantial part of lost earnings. He, however, establishes a federal cause of action (a federal liability system) that allows private individuals to sue in federal court—something the Superfund panel rejected—and makes defenses available to defendants similar to those in the Superfund law.

Evidentiary rules are liberalized in LaFalce's bill. Evidence would be admitted if it "tends to establish" causality, and the burden of proving medical causation would be met by the plaintiff's showing that the chemical "is reasonably likely to cause or significantly contribute to" the illness. To overcome the presumption of causation granted the plaintiff, the defendant would have to marshall a preponderance of evidence.

The victim's evidence-gathering efforts would be assisted by the federal government under LaFalce's proposal. Health & Human Services would determine that an environmental release occurred and then would establish its potential for injury or illness. After public comment, the government document could be used by the plaintiff as "conclusive evidence" to support the claim.

According to Alfred R. Light, an associate in the law firm of Hunton & Williams and author of an addendum to a soon-to-be released National Science Foundation study on the scientific basis for victim compensation, the LaFalce bill contains an unusual provision that tries to amend state workers' compensation law. It does this by writing a federal standard that incorporates presumptions that make it easier for the claimant to recover damages for occupational or general environmental exposure. "Then it tries to force the states to use these more liberal rules when paying workers' compensation," Light explains.

Sen. Mitchell is expected to offer less exotic fare. According to his aide Charlene A. Sturbitts, the Senator plans to introduce two bills "in the next month or so" to get discussion rolling of this "very controversial issue." One proposal, identical to the bill introduced last year, would increase the size of Superfund and open it to claims of personal injury, but compensate only for actual medical expenses. The second bill would incorporate the recommendations of the Superfund study panel.

Last year, Sen. Stafford joined with Sen. Mitchell in offering the amendment to Superfund allowing for private injury claims. This month or next, Sen. Stafford is expected to offer a proposal that could bear a striking resemblance to the original Senate Superfund bill (S. 1480), a Stafford aide says. That bill established a federal cause of action for injuries; provided for strict, joint and several liability for any release of a hazardous substance; and established a no-fault compensation fund (Superfund) that was not an exclusive remedy. In the new bill now being drafted, benefits would be paid from an en-

Japan's 10-year-old law compensates victims injured by pollution

Beginning in 1956, residents of Minamata, Japan, began to come down with a frightful illness that caused excruciating pain, paralysis, and even death. Children were born deformed. After painstaking sleuthing, the culprit was traced to methylmercury concentrated in the fish of Minamata Bay, the main dietary staple of the residents. The source of the heavy metal was the effluent from the area's primary industrial employer. Outbreaks of mercury poisoning have occurred elsewhere in Japan, but the disease has taken the name of the city that brought it to the world's attention: Minamata disease.

In the early sixties, residents of Toyama prefecture (similar to a state) could be heard to cry "Itai-itai," it hurts, it hurts. They had been poisoned by cadmium. Their bones became brittle. Many became crippled; some died. Their cries of pain became the name of the disease: Itai-itai disease.

Also at this time, in highly industrialized Yokkaichi—home to oil refineries, petrochemical complexes, and electric power plants—many residents contracted asthma, bronchitis, and emphysema.

Victims protested, companies denied responsibility. Finally, the situation reached a flash point. Victims' groups began to litigate their claims, seeking especially to get the companies to admit their culpability and accept responsibility. Decisions in four major trials were precedent-setting. Two Minamata disease trials and one Itai-itai disease trial eased the barriers to victim recovery by allowing use of epidemiological, clinical, and experimental data, and by shifting the nettlesome burden of causation to the polluters. The Yokkaichi air pollution case involving multiple sources and many different diseases further eased the victims' burden of proving causation, and expanded previous interpretations of polluter liability.

The Yokkaichi decision alone spurred passage of a victim compensation bill. But the legal principles developed in all four cases were codified in the 1973 Pollution-Related Health Damage Compensation Law. Polluting industries, not government, pay all the victim benefits, either through a tax on sulfur dioxide emissions, or on releases of cadmium, mercury, and arsenic.

Victims with designated diseases (asthma, emphysema, chronic bronchitis, Minamata disease, Itai-itai disease, and chronic arsenic poisoning) who live or work in officially designated pollution areas for a fixed period of time are eligible for reimbursement of medical expenses and loss of earnings after being certified by a special board.

Julian Gresser, coauthor of the 1981 book "Environmental Law in Japan" and visiting professor in the Massachusetts Institute of Technology's Program in Science, Technology & Society, claims the charges levied against industry act as deterrents to further pollution. What's interesting about the compensation law, he says, is that it links "this deterrent principle with the welfare objective" of compensating victims.

Because Japan "had a dynamic strategy for transforming industry, for moving it into a growth trajectory," it could tap the surplus generated from that growth to finance the social costs—the untoward health effects—of that development, Gresser says.

Can the Japanese compensation scheme serve as a model for the U.S.? No, says Gresser, not in its present form, "or even in a tinkered form." But the principles that undergird the law are transferable, he adds. The codification of statistical approaches to victim relief and the linkage "of an emissions charge to some sort of relief formula," are such conceptual building blocks that the U.S. can use to construct its compensation regime, he says. But he adds: "I think the whole issue of compensation schemes and how to deal with pollution damage need to be brought within the debate on industrial policy."

larged Superfund; taxes levied on industry could be increased or extended beyond the 1985 expiration date of the current law.

Correctly or not, these legislative solutions move the debate beyond the chemical industry's position of "let's see if there is a problem." In a subtle way, industry officials seem to acknowledge the shift. Monsanto's director of environmental affairs William J. McCarville asks: "If there really is a problem out there, is it of a magnitude that seems to require some type of new or different kind of solution?" Dow's Nute argues that even if there are scores of victims and even if the legal system doesn't work, a federal compensation fund is not necessarily the logical solution. "We might go to an insurance program or change the legal system," he says.

Legal experts on the Superfund panel rejected Nute's solutions as insufficient. That's why they recommended an administrative fund. They recognized the potential for mass tort claims: Love Canal alone has generated 13,000 private lawsuits, with pending claims of $2 billion plus for physical injury, pain, and suffering; property damage; and relocation costs. And they recognized that the factual and legal complexities of the issues made redress via existing state tort systems nearly impossible for the small claimant. Even more important, they acknowledged with their solution the level of public concern about hazardous substances.

A soon-to-be-released NSF study, "Compensation for Victims of Toxic Pollution: Assessing the Scientific Knowledge Base," underscores the Superfund panel's concern about the inherent tensions between science and law in the area of pollutant-related disease. By focusing on case studies of three chemicals—diethylstilbestrol, 2,4,5-trichlorophenoxyacetic acid, and nitrilotriacetic acid, the NSF report finds that social insurance programs (social security, public welfare, veterans' benefits, and workers' compensation) and traditional tort law remedies " have a limited ability to address the issues posed by pollutant-induced disease."

The foundation's report highlights the "problems faced in melding law and science in proving causation for victim compensation by showing the range of constraints and the problems encountered," says project director Sidney Draggan. To ask science alone to "apportion contributing factors to a disease is a little outrageous," Draggan says. Policy judgments also enter into that dissection, he explains. AFL-CIO's Samuels agrees, but adds: "I am trying to get the lawmakers to ask us not to distort the science, to get the laws written around the science for a change. It's a little different approach than we have had historically."

It's as different as MacBeth's witches tending their bubbling caldron with spells and an "eye of newt and toe of frog, wool of bat and tongue of dog" and the modern caldron of victim compensation with its witches brew of uncertain science, unsuitable law, dated social insurance programs, and ambiguous economics. The question is, when will talk of victims' compensation bubble over into political action?

The chemical industry is tending that caldron carefully, trying to keep the brew below the boiling point while it scampers for data. Data that it believes will help politicians decide whether a new mechanism—a compensation fund—or fine-tuning of existing institutions or a maintenance of the status quo is necessary.

An astute Senate staffer says that behind all the posturing, the chemical industry sees a victim-compensation fund as inevitable. Occidental's Friedman won't go that far. But he admits that the "thing that would create the most problems is a federal tort law system, and the thing that would create the least potential danger is a very tightly structured compensation board with no subrogation rights and a prohibition against the claimant's going into the court system."

Still, as a practical matter, moderate chemical companies recognize that society today is "at the same place as to disease compensation for workers and others as it was for workplace-accident compensation at the turn of the century," the staffer says. These firms will urge that the industry "wrest control of the situation by embracing or advocating a victims' compensation scheme," he says.

That hasn't happened yet, mainly because the industry has not sensed "a significant consensus on a waste site (or any other) compensation bill building in Congress," says CMA's vice president and general counsel David Zoll.

Zoll believes bills will be thrown into the hopper, but only as "platforms for discussion and debate." Ronald A. Lang, executive director of the Synthetic Organic Chemical Manufacturers Association, agrees. There will be a number of bills introduced, a number of hearings held, and a number of toxic tort riders tacked onto other bills as Congress reauthorizes environmental statutes, he says. "But I don't believe Congress will do anything before next year sometime," Lang says.

Next year is a Presidential election year, and the issue of compensating victims of hazardous substance exposure "has a broad-based populist appeal," says GRC's Outen. The Superfund law almost mandates that. It requires that one site in each of the 50 states be listed on the National Priority List of hazardous waste sites requiring remedial cleanup. Forty-six states have at least one site on the current list of 418 sites. "It is an issue much favored by public support, and it holds broad appeal to an official up for re-election," he adds.

Beyond parochial politics, the U.S. as a society must begin to make some hard policy decisions, and not on an ad hoc, environmental disaster by disaster basis. As outlined by Outen, society must decide how far the federal government should intrude in disputes between private citizens and corporations, how the rights of plaintiffs and defendants should be balanced, how and when uncertain science should be used in political and legal decisions, and how much risk is acceptable.

Writing in an essay on religion and race, the Jewish philosopher Abraham Joshua Heschel said: "Some are guilty, but all are responsible." His sentiment is echoed by retired Judge Charles D. Breitel, a member of the Superfund panel, who wrote: "All of us, in a social sense, are a cause of the problem, either as beneficiaries or as victims. All of us must pay for the consequences of toxic harm, but the cost must be shared justly and, at the same time, feasibly." □

Injury from Hazardous Chemicals: Compensating Innocent Bystanders

DANGER
ROAD CLOSED
HAZARDOUS
CHEMICALS

by Ronald B. Outen,
Government Research Corporation

In the lame duck session of the 1979-80 Congress two years ago, Senator George Mitchell (D-Me.), stood on the floor of the Senate and made this comment about the bill that shortly would become "Superfund," the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)[1]:

> This bill is deficient because while it provides for the cleanup of places, and compensation for damages to things, it provides nothing for what is the most important part of the problem: injury to people . . . I for one intend to exert every effort to remedy the irrational elevation of things over people in the next Congress.[2]

True to his word, Senator Mitchell introduced a bill in the 1980-82 Congress to compensate third-party damage claims using Superfund. No action was taken on the bill, however, and the hazardous waste victim compensation issue lay more or less dormant until late last summer.

Then, two things happened to push the issue back to center stage. The first was release at a House subcommittee hearing of portions of a report to Congress[3] from a blue-ribbon panel which had been studying the compensation problem. Creation of the panel by Congress was part of the 1980 compromise for dropping third-party compensation from the Senate Superfund bill. The panel, comprised of 12 attorneys, was instructed "to determine the adequacy of existing common law and statutory remedies in

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providing legal redress for harm to man and the environment caused by the release of hazardous substances into the environment."[4] The CERCLA Study Panel also was instructed to make recommendations for improvement of legal remedies available to people harmed by hazardous substances. The recommendations called for changes in state court rules and procedures to make it easier for private plaintiffs to win cases for damages. What really attracted attention, though, was the CERCLA Study Panel's call for a large fund to compensate private claims on a no-fault basis.

The point was driven home by the second development: A few days after the CERCLA panel made its recommendations, the Manville Corporation filed under the bankruptcy laws for protection from its liabilities. The filing had the effect of derailing an estimated 120,000 existing and anticipated private lawsuits for damages from asbestos exposure involving as much as $14.8 billion in liabilities.[5]

Suddenly, victim compensation had become a highly visible issue again,[6] and all signs point to extensive debate in the 1983-84 Congress. Already several proposals have emerged. They indicate proposed mechanisms of compensation and difficult public policy issues that will enter the congressional debate.

The Issue

The Environmental Protection Agency in 1980 estimated that around 56-million metric tons of hazardous waste are generated annually and that 90 percent of it was disposed of inadequately—in unsecured landfills, by improper incineration, or by midnight dumping.[7] There are numerous well-known instances of human injury and resource contamination resulting from hazardous waste dumps—Love Canal, Price Landfill, and Valley of the Drums, to name but three. In some cases damage has been extensive.

At Love Canal, for example, 100 families were evacuated, property values dropped substantially, groundwater was contaminated, workdays and income were lost because of illnesses, and there were burns and birth defects. In addition, there is concern over future cancers, mutations, and reproductive problems.[8]

It is not disputed that environmental degradation has occurred as a result of improper disposal and that persons exposed to hazardous substances released from dumpsites have experienced potentially compensable injuries and diseases.

'Difficult public policy issues will enter the congressional debate.'

What is not clear is how many injured parties there actually are. The CERCLA panel reviewed the widely disparate estimates of the number of hazardous waste dumpsites and concluded that it is impossible to accurately estimate the number of persons at risk.

Despite the uncertainties, however, there is growing concern that post-World War II industrial growth may have created an enormous pool of potential claimants who will perceive injuries and pursue claims as more is learned about past waste disposal practices, environmental fate, and chemical-induced diseases. The CERCLA Study Panel concluded that:

> Experience with occupational exposures to hazardous chemicals and with such substances as asbestos, Agent Orange, Kepone, PCB, PBB, coal dust, and DES indicates a substantial possibility of large numbers of latent injuries and future claims. Despite the lack of significant third-party awards in the past, a growing number of court suits are being filed and some request very high damages.[9]

Another pool of potential claimants includes individuals suffering property damage, disease, or injury as a result of spills of hazardous substances. The Department of Transportation (DOT) recorded some 78,000 transportation incidents involving spillage of some quantity of hazardous materials from 1971 to 1978. Though most of these spills were small, there nonetheless were 207 fatalities and 5,721 injuries. More than $16 million in property damage from highway and rail incidents was reported in 1978 alone.[10] The media frequently publicize spills which force evacuation of homes, damage water resources, or cause other harms. A case in point is the widely publicized derailment of a train carrying toxic chemicals that forced the evacuation of 2,700 people

> *'As individuals suffering harm become more aware of their past exposures and opportunities for compensation claims, the number of claims will increase.'*

in Livingston, La., last September. The State of Louisiana later sued the railroad and owners and producers of the chemicals for $9.8 million for cleanup cost and environmental damage. The railroad compensated displaced homeowners directly.

As individuals suffering harm become more aware of their past exposures and opportunities for compensation claims, the number of claims will increase. Several types of potentially compensable damages might result from a leaking dump or an accidental spill:

- harm to or devaluation of private property;
- damage to source of livelihood (e.g., fishery, tourist trade);
- personal injury, including medical bills, rehabilitation, pain and suffering, loss of life, and burial expense; and
- loss of income resulting from illness or disability.

Where the damage is apparent, immediate, and of obvious origin—temporary relocation because of a train derailment, for example—compensation at least for out-of-pocket expenses probably will be readily obtainable. More subtle damages associated with long-latency diseases such as cancer or delayed-effect injuries such as reproductive dysfunction present a different picture altogether. The CERCLA Study Panel concluded that no presently available mechanism can reliably, fairly, and efficiently compensate victims for diseases related to exposures to hazardous substances in the environment. Workers' compensation programs cover disease, but workers' compensation is not available to persons harmed outside the workplace. In any case, studies show that about 63 percent of disease claims are contested by employers (compared with about 10 percent for injury claims[11]), and only 5 to 7 percent of the claims are successful.[12] Superfund will compensate cost of cleanup and damage to publicly owned natural resources, but none of its $1.6 billion can be spent on private damage claims, as Senator Mitchell so forcefully noted. Thus, apart from any applicable public or private insurance coverage, the only avenue of redress is to sue the person or company believed responsible for the environmental contamination.

An individual who wants to sue an alleged polluter for damages must take the case to state court. The citizens suit provisions in the Clean Water Act, Clean Air Act, and other federal environmental laws authorize private actions to enforce the law—that is, to abate pollution by forcing compliance with the statute and regulations—but they do not authorize private lawsuits in federal court to recover damages.

A lawsuit for damages in state court is hard to win, however, especially if the claim is for a long-latency or delayed-manifestation disease such as cancer or birth defects. Consider the fictional story of Sally Jones in the box on this page. What obstacles must she overcome to win her case in court?[13]

In some states, her suit would be dismissed immediately. Her claim would be barred by statutes of limitation requiring that an action for damages be brought within, say, two years of the injury. Because Sally allegedly was exposed and first developed symptoms many years ago, her right to sue long since has been extinguished.

Let us suppose, however, that her claim is not barred in this way. Who does she sue? To expand the narrative a bit, let us say that the government's investigation reveals at least 13 chemical companies that used the dump site, which was itself operated by a series of owners over time. All the site owners and four of the 13 chemical companies have been out of business for years. The few surviving records (of the waste transportation company) and readable labels on a few buried drums show that at least nine of the 13 chemical companies contributed chemicals of the type that Sally *thinks* caused her disease. No one knows, however, how many barrels came from each

A Fictional Narrative

Sally Jones, age 32, recently was told by doctors that she has a chronic liver ailment that will require occasional hospitalization and probably will shorten her life. One day, she reads in the newspaper that the playground she used for several years as a child was built over an abandoned hazardous waste dump now listed by EPA as a Superfund priority. The mysterious oily areas and strange odors she remembers turn out to have been chemical wastes from corroded drums buried just under the soil surface. Having heard that such chemicals can cause disease, she goes to a specialist on such matters.

Yes, he tells her, liver disease of the type she has *can* result from exposure to some of the very chemicals identified at her old playground. What is more, the same chemicals can cause reproductive problems and they *may* have been responsible for her two miscarriages.

Sally believes strongly that she is an innocent victim and that someone should pay her compensation for her medical bills, pain and suffering, lost income, reduced life expectancy, and problems with childbearing. What problems will she have to overcome to be successful if she decides to sue for damages? What are her chances of receiving compensation?

CERCLA Study Panel: 'In hazardous waste cases, the problems of apportionment and allocation can be insurmountable barriers to recovery.'

company or which barrels had ruptured when Sally was a child.

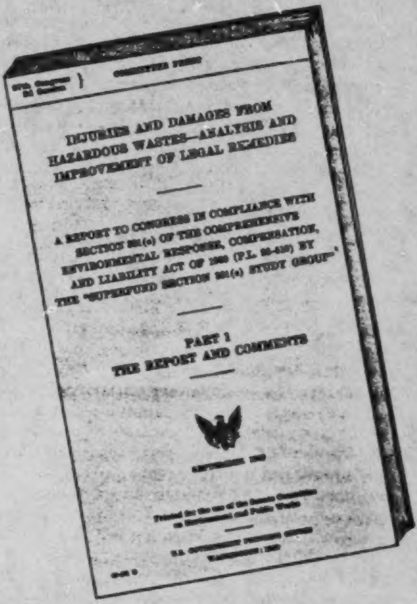
Sally's problem is this: she may face the burden of apportioning the liability for her claim among all the parties that contributed to her injury. Each company can defend itself by asserting that there is no proof that *its* wastes harmed Sally. The companies may assert also that they merely paid a waste transport company to remove the wastes, that they did not even know where it was taken.

The transport company, of course, can disclaim responsibility, pointing to the dumpsite owner. But which owner? The one who owned the site when the particular chemicals that allegedly harmed Sally were placed there? Or the last owner, who closed the site? Or perhaps the city as owner of the playground?

Sally, of course, can sue all parties associated with the disposal site, but how can she establish the proportionate liability of all her defendants? Furthermore, how does she sue companies now out of business? Does she really expect the remaining companies to pay for damages caused, at least arguably, by those that no longer exist? The CERCLA Study Panel concluded that, "In hazardous waste cases, the problems of apportionment and allocation can be insurmountable barriers to recovery."[14]

'Private litigant faces substantial barriers in an action to recover damages for personal injury or property damage.'

Sally's biggest problem, though, is likely to involve proving that the chemicals leaking from the dump actually caused her liver disease and her miscarriages. The relationship between chemicals and disease is not well understood. Medical science has not yet progressed to the point that it can meet legal standards of proof. In Sally's case, it would be impossible to quantify her exposure to various chemicals in the dump. Though there may be a statistical correlation between low-level exposure to those chemicals and Sally's ailments, in her particular case it may well be impossible to prove cause and effect. Over the years, Sally may have been exposed to numerous other causative agents which might have caused or contributed to her problem; her defendants will, of course, bring them into the open. She is flirting with a drinking problem. Perhaps alcohol caused or contributed to her liver disease. She tried some drugs in college, and who knows what they might do? What about dietary habits?



INJURIES AND DAMAGES FROM
HAZARDOUS WASTES—ANALYSIS AND
IMPROVEMENT OF LEGAL REMEDIES

A REPORT TO CONGRESS IN COMPLIANCE WITH
SECTION [illegible](e) OF THE COMPREHENSIVE
ENVIRONMENTAL RESPONSE, COMPENSATION,
AND LIABILITY ACT OF [illegible] (P.L. [illegible]) BY
THE "SUPERFUND SECTION [illegible](e) STUDY GROUP"

PART 1
THE REPORT AND COMMENTS

By this time we can see that Sally, whose story began with genuine harm to her well-being, is clearly getting nowhere with her claim. Even given the benefit of the doubt that the chemicals in the dump caused her ailments, she still will probably lose out to statutes of limitation, inability to apportion liability, and the large expenses of assembling expert witnesses and getting the case through trial.

Sally's story is fictional, of course, but the problems are real. Common law doctrines that might be used to establish liability—tresspass, nuisance, negligence, and strict liability, for example—have evolved to fill other social and judicial needs. The facts surrounding exposure to hazardous substances in the environment often do not match very well the situations that common law can easily resolve. After reviewing available common law remedies, the CERCLA Study Panel concluded that "although causes of action do exist for some plaintiffs under some circumstances, a private litigant faces substantial substantive and procedural barriers in an action to recover damages for personal injury or property damage due to hazardous wastes, particularly where the individual claims are relative small."[15]

Several recommendations for improving the prospects for compensation have been proposed: reduction of barriers to common law recovery in state court; creation of a federal cause of action; expansion of Superfund coverage; and creation of an administrative compensation system.

Common Law

The best known recommendations concerning state common law are those of the CERCLA Study Panel. The panel's recommendations included:

- use of a "discovery rule" in statutes of limitations. The cause of action would accrue from the time the injury was known, or reasonably should have been known, rather than from time of exposure.
- liberalization of rules of joinder so plaintiffs with similar claims could litigate in combination. This measure would increase efficiency by reducing the number of cases, and it would allow distribution of the costs of expert testimony. Once a combined trial had resolved evidentiary issues of causation and liability, separate trials could be held to establish the amount of damages.
- adoption of state rules that hold contributors to damage or injury jointly and severally liable, except for *de minimis* contributors. This measure would aid a plaintiff with a valid claim who is unable to apportion liability among several defendants.
- use of a formulation of strict liability that focusses on the nature of the hazardous activity itself. Other formulations that consider appropriateness of the location or balance its social utility against the plaintiffs harm would not be used.

Federal Cause of Action

Proposals involving a federal cause of action would permit private citizens to sue in federal court and would establish plaintiff's burden of proof and the defenses available to the defendant. Under a bill[16] introduced late last year by Rep. John LaFalce (D-N.Y.), whose district includes Love Canal and many other lesser known dumpsites, plaintiffs could recover damages for:

- illness, injury, or death;
- damage to or loss of real or personal property, including loss of use of property without regard to ownership;
- relocation costs;
- damage to or loss of natural resource, without regard to ownership;
- loss of income, profits, or earning capacity;
- pain and suffering;
- medical, rehabilitation, and burial costs; and
- direct or indirect loss of taxes and royalties to governmental bodies.

Liability would extend to vessel owners, the owner of a disposal facility at the time of disposal, transporters, and persons who arranged for disposal, treatment, or transportation of hazardous wastes. Defenses to liability under the LaFalce bill would be limited to an act of God, act of war, and unforeseeable acts of a third party not under the control of the responsible party.

Rep. John LaFalce, whose district includes Love Canal, is supporting comprehensive victims compensation legislation.

In litigation, the evidentiary burdens of the plaintiff would be eased. For example, the difficult burden of medical causality would be met by a showing that the chemical is "reasonably likely to cause or significantly contribute to" the injury or illness suffered by the plaintiff. Evidence would be admitted if it "tends to establish" causality. The defendant would be held to a preponderance of evidence test in defeating the presumption of causation granted the plaintiff.

Furthermore, plaintiff's burden of assembling scientific evidence would be relieved. In many cases, the federal government would be required to determine that an environmental release indeed occurred; the potential for and probable extent of injury or illness; and the type of injury or illness that might result from the particular chemical(s) involved. The government's study, completed after proposal and public comment, would be available as "conclusive evidence" to support a plaintiff's claim. Under the LaFalce bill, the court, not the plaintiff, would be responsible for apportioning liability among multiple defendants.

Superfund

A third type of proposal would build upon the existing Superfund by simply extending its coverage to include private claims. This approach was taken by Mitchell in S. 1486 in the last Congress. The Mitchell bill called on Superfund to cover out-of-pocket medical expenses, including diagnostic services, rehabilitation costs, and burial expenses. The same provisions were proposed by Mitchell and Senators Jennings Randolph (D-W.Va.), and Robert T. Stafford (R-Vt.), later in the 97th Congress,[17] using as a vehicle a bill to reauthorize the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The FIFRA proposal also would have increased Superfund from $1.6 to $5 billion, and it would have extended Superfund's industry taxation provisions by five years to 1990.

Administrative Fund

Perhaps the most controversial proposals, however, are those that call for a new administrative compensation system. Both the CERCLA Study Panel and the LaFalce bill proposed such a system.

Site of Livingston, La., train accident. (Source: EPA)

The CERCLA panel recommended a no-fault compensation fund to be administered by the states under federal law. The fund would be created initially by a tax on the oil and chemical industries and a surcharge on hazardous waste disposal. It would cover personal injuries from environmental contamination resulting from either hazardous substance disposal or spills. Injuries covered by workers' compensation and damage to private property would not be covered.

Under the CERCLA panel recommendations, a person could lodge a claim within three years after he discovered, or reasonably should have discovered, injury or illness. He would have to show that he had been exposed to hazardous substances and that he in fact is suffering a disease or injury "known to result" from those substances. He would then be entitled to a presumption of causation. As a further aid to claimants, the federal government would be required to publish documents that compile evidence linking major chemicals to the diseases they can cause.

Under LaFalce bill: Evidence admitted if it 'tends to establish' causality.

The LaFalce bill would establish a Toxic Victims Compensation Board. The Board would certify persons as victims of a hazardous substance release and award compensation. EPA would be required to support the Board by performing "hazardous substance release studies." The studies would determine whether a release had occurred, and whether EPA "reasonably believes" that the release created a potential for injury or damage and the probable extent of injury or damage. After public comment and final publication, the study would constitute "conclusive evidence" to support claims.

A number of different formulas could be used to determine the amount of compensation granted the successful claimant. The CERCLA Study Panel recommended that compensation cover all reasonable medical costs plus two-thirds of lost earnings. There would be a lost earnings ceiling (perhaps $2,000 per month) that would be adjusted from time to time to reflect changes in the economy. The LaFalce bill proposed compensating lost wages at 80 percent of actual lost wages or 80 percent of the statewide average wage, which ever is less.

Neither the CERCLA Study Panel proposal nor the LaFalce bill would establish the fund as an exclusive remedy or require claimants to irrevocably choose either the administrative or legal routes to recovery. Under both proposals a claimant from the administrative fund also could pursue the case in court. However, any duplicative awards would have to be reimbursed to the fund. The types of fund-compensable damages would be limited as described above, but of course a plaintiff could seek damages in court for pain and suffering, relocation expenses, property damage, and other damages not covered by the fund.

Should medical uncertainty be resolved in favor of assuming a cause and effect relationship? How much uncertainty would defeat this assumption?

In both the CERCLA Study Panel and LaFalce proposals, the fund would have subrogation rights to pursue a claimant's legal cause of action in court. This would allow the government to replenish the fund by lawsuits against parties responsible for the claimant's injury or illness.

Policy Issues

The victims compensation problem raises a number of difficult policy issues, and proposals like those described in this article, are certain to provoke heated debate. One question that will be asked is: How real is the victim compensation problem? The CERCLA Study Panel concluded that there is no way to estimate the number of potential claims. It can be argued that any action, especially the creation of a new bureaucracy to operate an administrative fund, is premature. On the other hand, if valid claims are not now being pursued because there is no effective remedy, how will we ever know how many "silent claims" are being unmet?

An extremely difficult question involves scientific and medical uncertainties. If the social goal is to identify and compensate valid claims, it is clear that traditional legal burdens of proof cannot reasonably be met. As a matter of public policy, should medical certainty be resolved in favor of assuming a cause and effect relationship? How much uncertainty would defeat this assumption? The CERCLA Study Panel and Rep. LaFalce recommend the use of government studies to link specific chemicals, diseases, and exposure levels. It goes without saying that such documents would be controversial and difficult to write. For example, any attempt to specify exposure scenarios capable of producing a cancer would trigger the endless debate about whether there are exposure thresholds for carcinogens. Every agency with statutory authority to regulate carcinogens (nearly two dozen at latest count) would be drawn into the debate because its resolution would affect their regulatory programs.

A closely related problem involves estimating and controlling program costs. The proposed compensation funds would be paid into on the basis of production and paid out on the basis of claims. This particular input/output model has contributed to the well-known problems of the Social Security System. For example, the usual prediction is that one person out of five will die from cancer. Because it is impossible to know how many cancers result from exposures covered by the fund, how can the boundaries of the compensation program be drawn? Would the fund deal only with diseases caused by dumps and spills? How could these disease events be separated from those arising from other environmental exposures or from the "ordinary diseases of life?"

An even more difficult ethical question: How much serious disease should be considered a reasonable cost of gaining the benefits of industrialization? As a society, we routinely accept such tradeoffs in terms of speed limits, use of diagnostic x-rays, etc. The analogy breaks down at the level of the individual, however. Should Sally Jones suffer her liver disease in silence, secure in the knowledge that society benefited from the industrial processes that contaminated her playground?

Another important issue involves the relationship between the no-fault administrative system and the adversarial court system of compensation. Should the former preempt the latter? Some supporters of an asbestos disease compensation fund[18] propose that a claimant who accepts a supplemental payment for damages not compensated by the fund relinquishes all rights to sue. The CERCLA Study Panel recommended that both avenues remain available, but that jury awards duplicating administrative awards be reimbursed to the fund. In the debate over an asbestos compensation fund, some companies have argued that their payment into a fund should relieve them of the threat of future private lawsuits. Concern about future liabilities can interfere with business planning and affect credit ratings. How should the individual's traditional legal right to seek redress in court be balanced against society's need to sustain a viable climate for business and industry?

Conclusion

The debate over hazardous waste victim compensation inevitably will affect, and be affected by, developments in other areas involving compensation for long-latency diseases. The asbestos compensation issue has been mentioned. In addition, there are ongoing debates involving proposals to federalize the workers' compensation system, establish uniform federal product liability legislation, and compensate Vietnam veterans who were exposed to Agent Orange. A number of interest groups will be affected: business and industry, labor unions, environmentalists, consumer activists, insurers, and trial lawyers, for example.

Rail cars carrying chemicals after Livingston, La., accident. (Source: EPA)

Because CERCLA calls for identification of at least one priority Superfund site in each state, there will be widespread political awareness of actual or threatened releases of hazardous wastes. How many members of Congress will hear from constituents who will claim to have been harmed in some way by these sites? The notion of compensating the "innocent bystander" has a certain populist appeal. It may well be hard to vote against a scheme that would compensate constituents like Sally Jones or the Love Canal families.

On the other hand, all the proposals thus far raise genuine problems that deserve close scrutiny. They involve some fundamental questions of public policy:

- the balance of rights between plaintiff and defendant—How should traditional burdens of proof be shifted?
- decisionmaking under conditions of uncertainty—How much scientific and medical evidence is enough to trigger action?
- the proper role of the federal government—How far should federal law intervene in disputes between private individuals and corporations?
- the ethics of acceptable risk—How much damage is acceptable? How much disease is too much?

These and other policy questions will have to be resolved, and it is not yet possible to predict the outcome in Congress. What can be predicted, though, is that the debate will be extensive and, in all likelihood, lengthy. Enough important legislators are committed to the issue to guarantee it a prominent place in the 98th Congress which just convened. ■

FOOTNOTES

[1] *Pub. L. 96-510.*

[2] Congressional Record, *p. S14973, November 24, 1980.*

[3] *"Injuries and Damages from Hazardous Wastes—Analysis and Improvement of Legal Remedies," Committee Print No. 97-12 (2 vols.), Senate Committee on Environment and Public Works, September 1982 (hereinafter referred to as CERCLA Panel Report); the recommendations chapter was released August 12, 1982, in testimony before the Subcommittee on Investigations and Oversight of the House Committee on Science and Technology.*

[4] *CERCLA Section 301(e).*

[5] *Testimony by the Manville Corporation before the Labor Standards Subcommittee of the House Education and Labor Committee, September 9, 1982.*

[6] *The Manville liability suits are distinguishable from the concerns expressed by Senator Mitchell, since they deal mostly with occupational exposure rather than wastes in the environment. Nonetheless, the Manville filing helped refocus attention on victim compensation issues generally.*

[7] 45 Federal Register, *33072-85 (1980).*

[8] *CERCLA Panel Report, vol. 2, Appendix J.*

[9] *Ibid., vol. 1, p. 32.*

[10] *"The Superfund Concept: Report of the Interagency Task Force on Compensation and Liability for Releases of Hazardous Substances," Department of Justice, June 1979, p. 4 (hereinafter cited as "The Superfund Concept").*

[11] *Peter Barth and Allan Hunt,* Workers' Compensation and Work-Related Illnesses and Diseases, *Dept. of Economics, University of Connecticut, October 1976.*

[12] An Interim Report to the Congress on Occupational Disease, *Department of Labor, 1980.*

[13] *The discussion of barriers to recovery in common law actions is based generally on the CERCLA Panel Report and The Superfund Concept.*

[14] *CERCLA Panel Report, p. 54.*

[15] *Ibid., p. 130.*

[16] *H.R. 7300, October 1, 1982, "The Toxic Victim Compensation Act."*

[17] Congressional Record, *p. S12947, September 30, 1982.*

[18] *Proposals for a compensation fund for victims of asbestos exposure have evolved during the past few years in response to the pressure of thousands of damage suits. The asbestos and insurance industry proposals generally would shield asbestos manufacturers contributing to a public fund from further private liability.*

POINT . . . AND COUNTERPOINT

A Solution In Search of a Problem?

As reported by Forum *staff*

Is there an "industry position" on proposals for compensating victims claiming damages from exposures to hazardous chemicals? If so, *The Environmental Forum* could find no responsible industry official willing and able to express that position within the deadline constraints for publication. *The Forum* directly contacted 15 industry experts representing 11 different companies, industry groups, and law firms representing those interests. Each regretted that industry's concerns might not be reflected in this feature, but no one was willing to "go public" on this controversial subject.

Based on extensive conversations with business interests, however, it is possible to put together this second-hand report on concerns the business community is likely to raise as positions take shape and as the debate heightens.

Is there really a problem? Or are funding proposals in effect *a solution in search of a problem?* That is likely to be a major question—in many ways, *the* major question—raised by business interests. They do not question the high numbers involved in the asbestos/asbestosis debate or perhaps even a few other cases (DES, Rely Tampon, Agent Orange). But they insist that assuming there are large numbers of legitimate claimants in this area requires an enormous leap of faith. Business interests simply are unconvinced that the numbers of legitimate claimants will come anywhere close to justifying substantial reforms of the legal system based traditionally on torts. They see the Manville bankruptcy/asbestosis episode as an easy case, but as bad legal precedent.

Staff *Continued on page 22*

Solutions to a Non-Existent Problem

by Leslie Cheek, III

Every extremist cause needs a "devil" to distract its adherents from reality. The devil for the advocates of "toxic tort" compensation proposals is the common law principle that a defendant is presumed innocent until proven guilty; the reality is the inability of most current scientific techniques to prove or disprove causal links between exposure to hazardous substances and the development of long-latency diseases.

The compensation advocates imagine that they can beat the devil by turning the fundamental principle of our system of civil justice on its head and that they can ignore reality by resolving all scientific uncertainties in favor of claimants alleging that exposure to hazardous substances caused their diseases.

Were they to succeed, they would give us a system in which our chemical industry would be absolutely liable for damage claims from the 20 to 25 percent of our population (44 million to 55 million people) that can expect to develop cancer of one type or another, because it would be impossible for any defendant to disprove a claimant's allegation that exposure to the defendant's chemical caused or contributed to the cancer.

The argument for a compensation system proceeds from the unexceptionable premise that persons harmed by exposure to hazardous substances should be compensated. The argument then goes on not to propose a non-fault alternative to our common law tort system, but rather to assert that the system is "inadequate" because it does not compensate every-

Cheek *Continued on page 23*

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Should society establish a specific means for compensating individuals who claim to be victims of exposures to hazardous chemicals? Is there a need for such a compensation program, and, if so, how should the merits of individual claimant's cases be weighed? Last fall's Manville Corporation bankruptcy in the face of some 16,500 asbestos/asbestosis suits, the Vietnam veterans/Veterans Administration wrangle over Agent Orange exposures, the Rely Tampons controversy, and the Superfund 301(e) study commission report—these and more assure that the debate will get increasing attention in coming months. Here's a look at issues likely to be raised:

The Case for Statutory Compensation

by Frederick R. Anderson

Congress should authorize an industry-generated, federally-administered fund to compensate persons injured by exposure to hazardous substances in order to close the remaining major gap in the environmental statutory system.

The issue here transcends the "mere" problem of compensating for injuries from hazardous substances, because two of the fundamental unresolved conflicts in modern public law lie at its core. The first is the profound conflict between, on the one hand, externalizing and spreading risks broadly to make some industrial enterprises more attractive, and, on the other, the more contemporary philosophy of shifting the burden of dispelling the uncertainty about risk and internalizing as many of the social costs of risky enterprises as possible. The second basic conflict in public law involves the choice between redress via the common law, and redress via statutory schemes which compensate through administrative agencies.

I favor the second alternative in each of these conflicts, which places me at cross purposes with both the insurance industry and American trial lawyers. My position is not to be envied.

Yet I have to differ. Regarding who bears the risks of industrial development, Congress has been correct, I think, in rejecting 19th century legal doctrines that cast some of the costs of entrepreneurial experimentation on the public: a precautionary approach is more attuned to the realities of hazardous, large-scale technology. Moreover, cost-internalization

Anderson *Continued on page 23*

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Compensate Yes, But Not to Exclusion of Common Law Remedies

by Frederick M. Baron

Although Ramazzini in the 17th Century wrote extensively of diseases "in the shops of craftsmen," still today many diseases caused by exposures to hazardous chemicals go unrecognized and consequently uncompensated. As stated by John F. Finklea, M.D., former Director of the National Institute for Occupational Safety and Health: "No matter how esoteric the causative agent, the diseases usually manifest themselves in relatively conventional forms. The problem is that their origin is frequently overlooked."

Similarly overlooked, from an historical point of view, has been the manner in which victims of exposures to hazardous chemicals have been legally compensated for economic losses sustained. Before the Fifth Circuit's landmark decision in *Borel v. Fibreboard Paper Products*, 493 F.2d 1076 (5th Cir. 1973) applying the law of strict products liability to an asbestos-related disease case, hazardous chemical/disease law amounted to a scattered group of cases and articles discussing problems of victim recovery for occupational diseases under pertinent state worker's compensation laws. Yet the failing was not with the "available law" itself, but with the general lack of understanding by the medical and legal professions about chemical related latent injuries. In the eight years after *Borel*, there has literally been an "explosion" in the number of claims filed and victims compensated. Using tools previously available, a whole new generation of "occu-

Baron *Continued on page 25*

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Staff

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A second major concern of business interests will involve scientific uncertainties over causes of illnesses. Given that all of us inevitably are exposed to toxic chemicals as a part of routine life (the benzene in gasoline is a frequent example, but one of many), how will the causes of an illness be apportioned among the myriad potential factors that could be culpable? How will lines be drawn among various exposure routes such as diet, smoking, exposure to radiation, exposure to industrial chemicals, hereditary factors?

If the potential causes of illnesses are broad-based, industry will ask, must not the funding of the compensation plan also be broad-based? This argument is likely to appeal in particular to the chemical industry, which fears being targeted with all the responsibility—and all or most of the cost—for environmental illnesses potentially due compensation. If society determines that exposure victims should be compensated through some special mechanism, will it decide also that funding should reflect an approximately fair allocation among industry and the general public?

The retroactive/prospective nature of a compensation mechanism also will be a major concern to business interests. Will they face liabilities for past actions which in large part were legal at the time and were taken "with all due care" under the prevailing conventions of the time? That, too, is likely to be among the concerns most often expressed by business interests in the victims compensation debate.

'Fundamental objectives' outlined.

Another concern that business interests have involves whether a special compensation system will provide exclusive or alternative reward. Industry's worst fear here is that a claimant might win an administrative settlement and then say, in effect, "See you in court." Business interests will point to potential redundancy with Blue Cross/Blue Shield and other health plans, unemployment compensation systems, Medicare/Medicaid, and so forth. They will ask that any special compensation program be exclusive so that it does not merely serve as a way to "finance tort suits."

Industry has other concerns too on this issue: Administration of a compensation fund must be carefully monitored to assure that there are adequate incentives for rejecting unwarranted claims; the extent to which liabilities are uninsurable; the political appeal to budget-hungry state and local governments of a revenue source not dependent on general revenues, and potential abuse of such an "off-budget" financing scheme.

But despite all its concerns, there were indications that most business interests will not outright oppose establishment of *any* compensation fund. Some hints of what some business interests might consider a workable proposal were offered by Washington attorney Kenneth R. Feinberg of Kaye, Scholer, Fierman, Hays & Handler on behalf of Raymark Corporation of Trumbull, Ct. Raymark manufacturers and markets energy absorption and transmission products, fastening systems, and custom-engineered products, some of which make it dependent on asbestos. The company "has been confronted with a deluge of litigation" over asbestos exposures, Feinberg has told a Senate Judiciary subcommittee.

'See you in court . . . fear of financing tort suits.'

Among "fundamental objectives" for a funding scheme, Feinberg lists the following [Keep in mind here possible differences between asbestos/asbestosis programs and "others"]:

—Pay adequate benefits.

—Process and pay claims promptly, avoiding delays.

—Decide claims on a no-fault basis in order to avoid costs and delays of the present tort system.

—Eliminate third-party tort litigation and provide an exclusive remedy.

—All responsible parties—manufacturers, their insurers, and the federal government—should fund the program.

—Each party's financial contribution should be based on specific, objective criteria that permit sound financial planning.

—Each party's contribution should fairly reflect its share of responsibility for the underlying problem.

—New government spending unrelated to government contribution to compensation should be "strictly limited."

—No new bureaucracy should be established.

—The compensation plan must be manageable, with administrative costs kept to a minimum and little intervention with existing problems.

Based on conversations with industry leaders on the victims' compensation issue, those are likely to be among the major issues and concerns expressed by industry. ■

Cheek

Continued from page 20

one whose harm may or may not have been caused by such exposure.

This argument ignores the fact that the tort system was never intended to compensate everyone who has suffered harm. Because of its requirement that claimants prove both (a) the existence and the breach of a legal duty owed them by defendants and (b) that the breach of this duty was the proximate cause of their harm, the tort system generally denies any recovery to approximately one-half of all claimants, whether their injuries are traumatic (e.g., automobile accidents) or chronic (e.g., asbestos-related diseases).

But the tort system is nevertheless still a devil, the argument continues, because some statutes of limitation begin to run from the date of exposure rather than from the date of discovery of disease, and because it requires claimants to establish, by a preponderance of the evidence, a cause-in-fact relationship between their exposure and the onset of their disease.

Anachronistic statutes of limitation are being addressed in the handful of states where they still exist; they cannot serve as the predicate for dismembering the tort system. Procedural and evidentiary rules designed to enforce the principle that a defendant is presumed innocent until proven guilty are found in every state, for they are the very soul of our adversary system of justice.

These rules make the system a devil still, the argument goes, because the defendant in a case of alleged hazardous substance injury is in a better position to absorb the costs of the harm through insurance and/or price increases than the claimant, and, in a context in which most scientific techniques can neither prove nor disprove a causal relationship between exposure and disease, the burden should be on the defendant to utilize his superior knowledge to disprove causation.

No 'devil' in our tort system . . . no need for a new compensation system.

While such an argument might be tenable if there were large numbers of deserving claimants currently going uncompensated or significant increases in the incidence of long-latency diseases, it makes no sense when there is not evidence to support either proposition.

Compensation advocates make much of the Love Canal "disaster" as an example of why a new system is necessary, but the fact is that *all* epidemiological studies of the Love Canal evacuees have shown *no* adverse health effects from their exposure to the canal's contents.

And there is *nothing* in the Superfund 301(e) Commission's report or elsewhere that suggests that the incidence of long-latency disease is increasing. In fact, the incidence of occupational diseases and the overall incidence of cancer has held steady or decreased slightly since 1933, with the single exception of respiratory cancer, which is plainly a function of smoking, not of chemical exposure. Advances in health and safety technology promise further reductions in disease frequency.

Compensation advocates should be directing their energies not toward the enactment of schemes that would debase both science and law to address a non-existent problem, but rather toward the creation and funding of mechanisms to identify, through responsible epidemiological studies, cause-and-effect relationships between certain durations and intensities of exposure to specific substances and the development of particular diseases.

Successful confrontation with the reality of the current incapacity of many scientific techniques to help claimants meet the time-tested requirements of the common law will demonstrate that there is no "devil" to beat in our tort system and therefore no need for a "toxic tort" compensation mechanism. ■

Anderson

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suggests that successfully running the regulatory gauntlet should not relieve hazard generators of the obligation to compensate if injuries still occur, despite regulation. Compensation should still be made without regard to fault, and without the archaisms of common law trials and attorneys' fee arrangements which delay and vitiate recovery. Because the system of common law redress is doctrinally underdeveloped, slow, often inequitable, and invariably inefficient, at least in the context of prolonged low-level chronic exposure to hazardous substances, Congress should legislate an alternative system.

Spreading risks too broadly, or limiting recovery to make insurance policies easier to write, would significantly undercut the long-term incentive to avoid social costs which no-fault compensation creates. Thus I lack sympathy for insurers' desires to spread risks broadly and to confine any new compensation scheme to more easily-definable insurable events. Let me turn to some specific issues that arise in developing an administrative compensation proposal.

The fund should be collected from chemical industry fees, just as Superfund currently is, to internalize damages to the major harm-causing enterprises. Injury from exposure to chemical wastes disposed of years ago likewise should be compensated from current chemical industry fees, because it is fairer to internalize costs to current beneficiaries of an enterprise than to transfer costs to present taxpayers in general. The argument that the public at large benefited from the earlier production of chemicals, so public revenues should be used to compensate victims, is, I think, both inaccurate and (if you believe strongly in cost-internalization) irrelevant. Firms undertaking product development of all sorts should expect that sooner or later their full social costs will be borne by them or their successors, rather than by taxpayers or medical insurers, regardless of how sincerely ignorant firms are of their new products' potential to do harm over the long run.

I carry cost-internalization further. I favor a federal hazard surcharge or injury tax for firms which cause excess injury rates. I also favor federal supervision of insurance premiums to ensure that "bad actors" pay at higher, disincentive-creating rates. Finally, I would give teeth to the subrogation provisions which in most current proposed versions offer almost no encouragement to the fund administrator or to seek reimbursement for the fund from individually responsible enterprises. In fact, with respect to cost-internalization, liberalized common law recovery is more appealing than the administered fund approach, because common law recovery would narrowly focus responsibility on individual defendants. Of course, true orphan sites do not permit this approach, but then again easier common law recovery itself provides a strong incentive to potential plaintiffs and their lawyers to "gumshoe" and locate a responsible defendant, thereby removing the site from the orphan category.

Insurers and generators raise a number of issues about the scope of liability and insurance coverage. The problem of large, difficult-to-insure potential liability begins with the types of substances, uses, and disposal practices to be covered by the fund. I think the fund should cover all chronic progressive diseases attributed to chemical substances, no matter how a person encounters them. Special interests may obtain exceptions, (e.g., for tobacco products) but diseases contracted at home, work, or elsewhere in principle should all be covered. The congressional §301(e) commission on which I served limited its recommendations to injuries from hazardous waste disposal, but the list we provided of leading examples of dangerous chemicals itself undercuts our narrow focus on wastes, because most chemicals on the list are not exclusively encountered as wastes (asbestos, Agent Orange, Kepone, PCBs, PBBs, coal dust, and DES). Pesticides, household products, fertilizers, and industrial solvents used in garages, print shops, and dry cleaners find their way into groundwater, water, or air without the intermediary of a waste dump. Fortunately, Congress can apply our proposal broadly if it wishes by expanding our definitions and by adjusting existing statutes for the protection of consumers, workers, patients, travellers, and others to fit our basic framework.

Insurers criticize compensation proposals which would impose strict liability on numerous firms for the same injury even though the injury cannot be causally linked to a particular policy holder, time period, or industrial activity. They are particularly critical of easing the burden of proving the causal connection via the liberal rebuttable presumption provisions contained in practically every compensation proposal. Insurers think these characteristics may create unmanageable costs even if benefit awards are held to modest levels.

Assuming acceptance of a federal scheme, what would the insurers want in it? A clear causation requirement, no multi-source nor retroactive liability, and schedules of limited awards for conventional diseases only. They would prefer a fault-based system but begrudgingly accept strict statutory liability as the price for the more insurable scheme which they hope Congress will substitute for open-ended common law liability.

I have a certain sympathy for "channelling" liability insurance costs onto one insurer so the liability of peripherally-involved firms can be reduced. But in the end, a greater concern is to have a fully solvent and insured source available to compensate victims when the time comes than to eliminate the contingent liability of handlers of dangerous substances.

"Retroactive" awards are an undesirable practical necessity given that "old" and "new" waste deposits, emissions, and the like mix in the environment. I think the 301(e) study panel erred in limiting liability to wastes created *after* the statute is enacted.

This is not the place to debate rebuttable presumptions in detail. Reform-minded critics of the tort law system agree that legislative reform of causation principles will be necessary before victims can be equitably compensated. There is no other way; the certainty accompanying airplane accidents and nuclear disasters is impossible with asbestos or chemical wastes. Along with the rest of us, insurers and manufacturers must learn to live with uncertainties that affect the opportunities and obligations of modern economic enterprises.

Nor is severely limiting harms or awards to what we can "afford" the way to go. Generous recovery is both necessary and feasible, and it must cover—in addition to wages lost and medical (and burial) expenses—impaired fertility, chronic miscarriage, various forms of neuropathology, teratogenic effects, and fear of future cancer or of transmission of genetic injury to future generations—all difficult to put a price on in any form, but worth the effort for an adequate compensation scheme. Medical science can help in making these awards just and adequate, rather than having them small and definite merely because they are somewhat subjective and still imperfectly understood from a medical viewpoint. Use schedules to make such awards? Yes, if necessary, correcting the mistakes also made with the much-maligned workers compensation plans.

Common law recovery should be curtailed if a claimant elects to accept compensation from the fund. Why not allow multiple forums? Primarily because limiting additional recovery at common law to "safety valve" cases will help minimize additional indirect costs or "transactions costs" (duplicative forums, court costs, witness and attorneys fees, etc.), which can be enormous. I disagree with the majority of the 301(e) study commission, which recommended leaving common law actions essentially undisturbed (and unimproved, despite Judge Breitel's and my regret that we did not also recommend tort law reform). Remember that we were all lawyers, and new procedures are what a committee of lawyers inevitably will propose. Yet at some point generating redundant procedures becomes the jurisprudential equivalent of the Treasury's printing new money, with similar results. In fairness, the majority did suggest that court costs and expert witness fees be imposed on the claimant in the judge's discretion if tort recovery does not exceed the fund award by more than 25 percent.

I subscribed to a minority view, which four members expressly endorsed and another four would clearly have been willing to endorse, I believe, had it not been for three members' virulent opposition to any change whatever in the existing tort system. The "minority" would bar a subsequent tort action except where fundamental fairness requires allowing it to proceed, for example if the claimant seriously mistook the extent of his injury. ■

Baron ***Continued from page 21***

pational disease lawyers" has successfully created precedent for compensating victims of hazardous materials such as pesticides, benzene, lead, phosgene, radiation, and dozens of others. In the area of asbestos litigation alone, literally thousands of victims have been compensated. The claims have proven so successful that at least three major suppliers (despite their admitted solvency) have attempted to use the Bankruptcy Act to press for congressional relief from the payment of claims. The national publicity gained by this ploy certainly should have a deterent effect on some of the questionable practices of other manufacturers of hazardous chemicals and should likewise create an even greater incentive for research and testing of products. Certainly both the real and perceived incentive of manufacturers to "clean up their act" caused by this litigation has been a greater stimulus than the various environmental and safety regulations supposedly enforced by EPA and OSHA. The old articles describing the pitfalls of hazardous chemical litigation are, by and large, no longer applicable in common law litigation.

This is not to say, however, that certain problems do not exist. The most glaring deficiency in our tort compensation scheme is in handling cases for the victim who has suffered a relatively minor loss. Although the common law damage suit may provide a substantial recovery for a seriously injured victim, it is often costly and time consuming. The tier one scheme suggested by the Section 301(e) study group provides an excellent solution to the problem.

'No' to eliminating common law compensation

Under this proposed federal administrative remedy, claimants may file for limited benefits for economic losses suffered as a result of exposures to hazardous wastes, as defined in the Act. The claim would be handled much like a state worker's compensation claim, but the critical difference would be in the utilization of a series of rebuttable presumptions established by the agency. Rather than requiring the injured individual to present expert testimony concerning the etiology of his condition, a rebuttable presumption (if applicable) would be created to establish a prima facie showing that the exposure caused the disease condition in question. In the "routine" case, this would eliminate many of the costly procedures otherwise required to establish facts which really should be accepted as true anyway. Because liability or fault is not an issue in these claims, they should be adjudicated in a reasonably expeditious manner.

Perhaps the greatest conflict among the members of the 301(e) group was on whether to make this tier one remedy a truly exclusive compensation remedy for victims that would eliminate the right to pursue common law remedies. Fortunately, the majority of our group recognized the value of a substantial recovery for injured claimants and also of the deterent effect on maintaining unlimited liability for negligent producers and users of hazardous chemicals. The 301(e) group properly voted not to eliminate common law rights.

The trade-off, if it can be called that, was an "exit toll" which essentially acts to penalize the over-litigious claimant and thus deter specious claims from clogging the court system. Although I would have preferred to eliminate this device entirely in favor of a free access system, I am gratified that no serious consideration was given to eliminating the right of victims to receive common law compensation. It is this very remedy, utilized through our civil jury trial system, that guarantees victims of hazardous chemicals their right to seek full and complete compensation for their injuries and—individually rather than bureaucratically—prevent future abuses by those who economically benefit from the use of hazardous chemicals. ■

Toward An Improved Compensation System For Persons Exposed To Toxic Wastes

by Joan Z. Bernstein and William L. Powers

Nobody is satisfied with the current system for compensating individuals injured by exposure to toxic wastes. Victims complain that the peculiarities of the law make any recovery uncertain and, even then, prevailing in court may take years if not decades and at enormous cost. Industry, however, is harassed by an extraordinary number of lawsuits, many of which are viewed as frivolous, but with the uncertainty of litigation yielding potential billion-dollar exposure.

These widespread dissatisfactions have pressured Congress to try to respond to these concerns legislatively by devising a new system for compensating those injured by exposure to toxic wastes. The basic questions are: who should be compensated, how much, and by whom? Beyond that, the system should encourage sound, cost-effective disposal procedures for wastes today and in the future.

Major Problems in the Current System

DIFFICULTIES TO RECOVERY FOR INJURIES DUE TO EXPOSURE TO TOXIC WASTES

The legal barriers facing an individual seeking compensation for injuries believed to have been caused by exposure to toxic substances are substantial. Plaintiffs often find it difficult to prove that their injuries were due to the gradual toxic effects of a particular substance. Little is known about the toxic effects of many substances, and many of the injuries caused by toxic substances may also be caused by or aggravated by other factors such as diet, smoking, general pollution, or the aging process. Even if cause and effect are established, it still may be hard to show that a particular person or company was responsible. Few records exist listing the firms which contributed to a particular site and the substances each deposited there.

Even if these elements can be proven, a plaintiff may find that the expense involved in assembling and presenting the proof to a jury exceeds the compensation he is seeking. Furthermore, the firms responsible for the plaintiff's injuries may no longer be in business or may lack the financial ability to fully compensate the plaintiff. Finally, the plaintiff may be barred by the statute of limitations from bringing suit if several years pass before the toxic effects become noticeable or before the plaintiff suspects his injury was caused by toxic exposure.

INDUSTRY PROBLEMS

Industry, on the other hand, faces the prospect of paying enormous compensatory awards for actions which, at their time, were considered responsible and socially beneficial. Many of the substances now suspected of having toxic effects played instrumental roles in the unprecedented economic growth and increase in living standards of the past forty years. To criticize or penalize industry for engaging in practices we only now suspect may involve significant health risks seems basically unfair.

Of at least equal concern to industry is the high degree of uncertainty resulting from the prospect of enormous adverse judgments. This uncertainty makes corporate planning difficult, and drives up the cost of doing business.

Economists and others argue that these costs should be passed to consumers so that the prices of goods reflect their true social cost. As a practical matter, however, that concept may be impossible, since manufacturers have little idea whether the sums they will be required to pay will be negligible or enormous. In view of this uncertainty, the overall price we all may pay is that useful new substances are withheld or withdrawn from the market.

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Goals To Be Reached With a New System

REDUCE COSTS AND SPEED UP HANDLING

Ideally, modifications in the existing system would result in reaching two goals: (1) speedy compensation to all victims of toxic exposure; and (2) minimizing the uncertainty each manufacturer faces over the amount of compensation it may have to pay.

In addition, a new system would reduce the cost of making compensation decisions and encourage manufacturers to reduce their reliance on toxic substances and (where possible) comprehensively improve handling and disposal practices.

The latter requires holding each manufacturer accountable to some extent for the injuries that can be traced to it. At least theoretically, if the payments a manufacturer were required to make were not dependent on his conduct (e.g. the level of toxic injuries in the entire industry), he would have little incentive to reduce reliance on toxics or to employ safer handling techniques. Indeed, the firm which desired to adopt more stringent safe-guards would be deterred from doing so by costs of such safeguards and competitive pressure exerted by other firms.

LEGISLATIVE PROPOSALS

A more difficult issue is the extent to which industry should pay all the costs associated with past disposal practices, especially where the firms involved were employing the best available handling techniques at the time. This concern is even more compelling if the consequence of shouldering all such costs is the bankruptcy of an entire industry.

Industry already bears most of the costs, and probably will continue to...particularly where such costs can be reflected in the price of the goods manufactured. That burden is justified in a competitive economy, by the fact that the pricing mechanism best ensures that the costs and benefits of particular products are balanced.

The prinicpal legislative proposals now circulating in Congress are:

(1) Proposals affecting potential victims

  (a) modifying the current tort law to reduce the burden of proof

  (b) changing the statute of limitations so that the time runs, not from the date of exposure, but rather, either from the time the claimant knows of his injury or from the time he discovers his injury is due to toxic effects

  (c) new rules which would make it easier for several plaintiffs to jointly sue multiple defendants.

(2) Proposals affecting manufacturers' liability

  (a) setting limits on the size of a particular award

  (b) establishing uniform liability principals so that compensation does not depend on the jurisdictional rules of particular courts.

(3) Systemic Proposals

  (a) establishing an administrative fund to operate in lieu of or in conjunction with court litigation

  (b) expand the Superfund to embrace victims of Superfund-related damage and permit personal claims for damages. Under this proposal, Superfund collections would be doubled and claimants could seek recompense for health costs and wages lost as a result of illness-related Superfund sites.

REDUCING THE BURDEN OF PROOF

A plaintiff must now prove "by a preponderance of evidence" that his injury was caused by exposure to toxic substances and that the defendant was responsible for the plantiff's exposure. It has been proposed that the standards for proving causation be relaxed and the number of manufacturers which may be held "responsible" for a toxic injury be increased.

For example, a plaintiff might only be required to show that (1) he suffers from an injury; (2) his type of injury is more likely to occur if he has been exposed to a particular toxic substance; (3) there is a reasonable chance he has been exposed to that substance; and (4) there is a reasonable chance that the source of the exposure was once in the control of the defendant.

That change is appealing in that it would reduce the time and expense involved in litigation, but it also has several drawbacks. First, while the number of people receiving prompt compensation for injuries caused by toxic exposure will increase, so will the number of people being compensated who are not entitled to recovery. Reducing the burden of causation may lead to compensatory payments far in excess of actual injuries and costs to industry and society far in excess of the benefit of prompt payments to some.

For example, assume a city with a hazardous waste landfill is found to have a 20 percent higher incidence of liver cancer. It is almost impossible for doctors to identify those who contracted liver cancer because of the land-fill. If the firms who contributed to the landfill must pay compensation to every person who contracted liver cancer, they will end up paying amounts many times greater than the level of injuries actually attributable to the hazardous wastes. While such enormous excess payments might serve some socially useful purpose, the most likely result would be that certain products are withdrawn from the market or priced far too high.

Two partial solutions to this problem are possible: (1) reduce the size of each plaintiff's award (see below); or (2) have the government pick up the tab for payments in excess of the total estimated cost of injuries attributable to the toxic wastes.

A second major drawback to reducing the plaintiff's burden of proof is that it exacerbates the uncertainty each manufacturer would face over the total payments it could be required to make. Adding to the uncertainty is the increased possibility that a manufacturer will be held liable for the poor handling practices of another firm which, for example, may have disposed of toxic substances at the same site as the defendant. This inability to control one's own liability not only increases the manufacturer's risk but, as discussed earlier, reduces its incentives to improve the safeguards.

Alternatives To Consider

CHANGING THE STATUTE OF LIMITATIONS

Currently there is wide variation among various jurisdictions as to when the statute of limitations begins to run for a particular claimant. Sometimes it is the date of exposure to the toxic wastes, and at other times it is when the claimant first becomes aware of his injury. Proposals have been made to set a uniform period that starts when the claimant learns of the possibility that an injury may have been caused by toxic wastes.

While uniformity in this regard would eliminate the costs of constantly relitigating this issue, and may be fair in that persons otherwise entitled to recovery are not disadvantaged because they happen to live in a jurisdiction with an unfavorable rule, such a change increases manufacturer exposure and uncertainty by extending into the indefinite future the time when they face a lawsuit.

NEW RULES FOR A CLASS OF PLAINTIFFS TO SUE MULTIPLE DEFENDANTS

While such rules would be designed to reduce litigation expense, and are easy to favor in the abstract, experience suggests that any new rules are likely, at least in the short run, to generate litigation with attendant costs and delays. Care and caution should be the guiding principles so that the value of new rules is not undermined by a swamp of litigation.

LIMITING MANUFACTURERS' LIABILITY

Never proposed by itself, but often along with other proposals, are possible limits on a manufacturer's liability for toxic torts. Two approaches under consideration are (1) to compensate only for medical injuries and a percentage of lost wages (not for pain and suffering); or (2) to place a ceiling on compensatory awards.

Limiting liability would enable courts or Congress to reduce a plaintiff's burden of proving causation without significantly increasing the manufacturer's uncertainty as to the total level of payments it might be required to make. Administrative costs and court time would probably decrease since it would be unnecessary to prove damages outside the limits of liability.

The obvious drawback to limiting the size of the award is that a particular person may not be fully compensated for his injuries. However, more plaintiffs would recover, and litigation expenses by all parties would be reduced.

Here again is a concept that everyone can support in the abstract but which may fail in the absence of a consensus as to what the principles should be. Without the consensus prompt Congressional action is unlikely.

ESTABLISHING AN ADMINISTRATIVE FUND

A proposal that has attracted a lot of attention is one that would establish an administrative fund from which injured parties would receive compensation upon showing only that their injuries were attributable to toxic exposure. Plaintiffs would not have to prove who was responsible for the source of the exposure. The fund would be financed by a tax imposed on the production of toxic substances and by payments from firms proven by the government to have been responsible for some of the claimants' injuries.

At least two versions of this proposal have evolved. One would bar an injured party from suing in court if he were eligible to be compensated from the fund. The other would let injured parties seek awards in both forums. If the fund provided only limited compensation, an injured party might be able to obtain a much higher award in court. But the plaintiff would be required to prove in court the defendant's responsibility for the plaintiff's injury. If the plaintiff succeeded in obtaining a court award he would be required to repay any award he had received from the fund (up to the amount received in court).

The principal benefit of the administrative fund, at least in theory, is that the injured party would be able to obtain compensation much faster and at less expense than he would from a court. Furthermore, the plaintiff would no longer face the danger of finding the responsible company out of business or otherwise judgment-proof.

Casting some doubt on this theory, however, is the experience of coal miners attempting to collect compensation for black lung disease under a similiar administrative structure. Long delays and complex procedures have replaced the fast, efficient system originally envisioned by the policy architects. Before establishing a similar system for toxic exposure victims, we should thoroughly analyze the black lung program to avoid the same mistakes.

Assuming the administrative fund would operate as envisioned, its proponents argue it will significantly reduce manufacturers' uncertainty. Whether it does, however, depends largely on the rules followed by those distributing payment from the fund. If, for example, a more liberal burden of proof were applied to claims and some manufacturers would be held responsible in some circumstances, manufacturers' uncertainty would not be reduced. Moreover, manufacturers would still face unacceptable levels of risks if claimants were still permitted to seek a larger award in court.

Conclusion

From the multitude of goals, interests, economic forces, tradeoffs, and administrative realities which must be considered, the faint outline of a reasonably firm and efficient program for compensating people harmed by exposure to toxic substances can be discerned.

First, the level of proof required to establish a connection between the claimant's injury and exposure to a toxic substance should be reduced to some extent. In return, the size of the claimant's award should be limited. These limits should be exceeded only by proof of gross negligence on the part of the defendant. An administrative fund would eliminate the need for claimants to determine the identity of the firm responsible for injuries and would therefore, at least in theory, further reduce the expense and time involved in obtaining a compensation award. But before creating such a structure, the failings of the black lung disease compensation program should first be thoroughly examined.

Whether a program, if any, which emerges from Congress will share any of these elements is not yet clear. However, the pressure on Congress for action becomes more intense daily and thus increases the likelihood that it will act soon.

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HAZARDOUS WASTES: NEW RIGHTS AND REMEDIES?

THE REPORT AND RECOMMENDATIONS OF THE SUPERFUND STUDY GROUP

James R. Zazzali[*] *and Frank P. Grad*[**]

This Article is an outgrowth of the § 301(e) Study Group Report. Summarizing the 800 page Report, the Article focuses on the essential findings and recommendations of the Study Group. It relies to a great extent on the detailed information and research material compiled in the preparation of the study. As a consequence, a significant portion of the Report is restated in this Article.

I. INTRODUCTION

In late 1980 the United States Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)[1]. The legislation created what is now known as the Superfund, a trust fund to finance the expenditure associated with the cleanup of hazardous waste sites and toxic spills.[2]

CERCLA makes no provisions for the recovery of damages for personal injury and property damage resulting from exposure to hazardous wastes, although there was frequent reference to such individual injuries in the course of the legislative history.[3] An earlier bill discussed during the enactment of CERCLA provided for some such recovery,[4] including awards for the medical costs of injury,[5] but during the closing part of the 96th Congress, the "lame duck" session following the 1980 elections did not address these difficult issues.[6]

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[1] 42 U.S.C. §§ 9601-9657 (Supp. IV 1980).

[2] *Id.* § 9611.

[3] *E.g.*, S. REP. NO. 848, 96th Cong., 2d Sess. 1, 13 (1980) (imposition of liability ensures "that those who caused chemical harm bear the cost of that harm"); *see* Grad, *A Legislative History of the Comprehensive Environmental Response, Compensation and Liability ("Superfund") Act of 1980*, 8 COLUM. J. ENVTL. L. 1 (1982).

[4] *E.g.*, S. 1480, 96th Cong., 1st Sess. § 4 (1980) [hereinafter cited as Senate Bill].

[5] *Id.*; Grad, *supra* note 3, at 13.

[6] *See* Grad, *supra* note 3, at 19.

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Instead Congress, in section 301(e) of CERCLA, provided for the creation of a Study Group to deal with this contentious problem.[7] Congress authorized the Study and called for a Report precisely because the problem is a newly emerging one, involving some novel and serious injuries with extended latency periods, for which existing law offers few ready answers. It is clear from the provisions of section 301(e) that Congress was well aware of the difficulties likely to be encountered by private lawsuits for hazardous waste injuries. The Study Group authorization provides in part:

> (1) In order to determine the adequacy of existing common law and statutory remedies in providing legal redress for harm to man and environment caused by the release of hazardous substances into the environment, there shall be submitted to the Congress a study within twelve months of enactment of this Act.
>
> (2) This study shall be conducted with the assistance of the American Bar Association, the American Law Institute, the Association of American Trial Lawyers, and the National Association of State Attorneys General with the president of each entity selecting three members from each organization to conduct the study. The study chairman and one reporter shall be elected from among the twelve members of the study group.
>
> (3) As part of their review of the adequacy of the existing common law and statutory remedies, the study group shall evaluate the following:
>
> (A) the nature, adequacy, and availability of existing remedies under present law in compensating for harm to man from the release of hazardous substances;
>
> (B) the nature of barriers to recovery (particularly with respect to burdens of going forward and of proof and relevancy) and the role such barriers play in the legal system;
>
> (C) the scope of the evidentiary burdens placed on the plaintiff in proving harm from the release of hazardous substances, particularly in light of the scientific uncertainty over causation with respect to—
>
> (i) carcinogens, mutagens, and teratogens, and
>
> (ii) the human health effects of exposure to low doses of hazardous substances over long periods of time;
>
> (D) the nature and adequacy of existing remedies under present law in providing compensation for damages to natural resources from the release of hazardous substances;

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[7] *See* Pub. L. No. 96-510, § 301(e), 94 Stat. 2767, 2807 (1980) (codified at 42 U.S.C. § 9651(e) (Supp. IV 1980)).

> (E) the scope of liability under existing law and the consequences, particularly with respect to obtaining insurance, of any changes in such liability;
>
> (F) barriers to recovery posed by existing statutes of limitations.
>
> (4) The report shall be submitted to the Congress with appropriate recommendations. Such recommendations shall explicitly address—
>
> (A) the need for revisions in existing statutory or common law, and
>
> (B) whether such revisions should take the form of federal statutes or the development of a model code which is recommended for adoption by the states.[8]

The United States Department of Justice requested that the four designated organizations appoint members to comprise the Study Group.[9] On June 8, 1981, the recently appointed members met at the Justice Department in Washington for their initial organizational meeting.[10]

The law which authorized the diverse composition of the Group indicates that no easy consensus was sought, but that Congress had intended to reflect a variety of interests in the Study Group. In fact, differing views and sharp dissensions on policy characterized many of the Group's deliberations.[11] It was probably also expected by some at the time of the enactment of the legislation that the differences in viewpoints among the four professional organizations which supplied the membership of the Group would lead to an inconclusive report. Nevertheless, the membership agreed that the public trust required the solution of the problem. Therefore, despite an inauspicious start and contrary to early expectations, the final Report reflects the substantial agreement of the Study Group.

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[8] *Id.*

[9] The following members of the Study Group were designated: by the American Law Institute: the Hon. Charles D. Breitel, Counsel, Proskauer, Rose, Goetz & Mendelsohn, New York, former Chief Judge of the New York Court of Appeals, Jeffrey O'Connell, Professor of Law, University of Virginia School of Law, and Professor Frank P. Grad; by the American Bar Association: Weyman I. Lundquist, Esq., Heller, Ehrman, White & McAuliffe, San Francisco, California, Frederick R. Anderson, Professor of Law, University of Utah College of Law, and George Clemon Freeman, Jr., Esq., Hunton & Williams, Richmond, Virginia; by the American Trial Lawyers Association: Richard F. Gerry, Esq., San Diego, California, President of ATLA, Norman J. Landau, Esq., New York, and Frederick M. Baron, Esq., Dallas, Texas; by the National Association of Attorneys General: Rufus L. Edmisten, Attorney General of North Carolina, Warren R. Spannaus, Attorney General of Minnesota, and former Attorney General of the State of New Jersey, James R. Zazzali. *See* Special Report to Congress, INJURIES AND DAMAGES FROM HAZARDOUS WASTES—ANALYSIS AND IMPROVEMENT OF LEGAL REMEDIES, IN COMPLIANCE WITH SECTION 301(e) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT OF 1980 BY THE "SUPERFUND SECTION 301(e) STUDY GROUP" Vols. I & II, 1, 17-18 (*reprinted as* Comm. Print for the Senate Comm. on Envtl. & Pub. Works, Serial No. 97-12, 97th Cong., 2d Sess., 1982) [hereinafter cited as REPORT]. The Study Group members were not expected to represent their respective designating organizations, nor were they expected to seek instruction or approval from those organizations.

[10] *Id.* at 18-19.

[11] *Id.* at 6-7.

The designees of the National Association of Attorneys General were the Attorneys General for New Jersey, Minnesota, and North Carolina. There were particularly compelling reasons for the designation of the New Jersey Attorney General. New Jersey's extensive experience with the toxic waste problem,[12] the autonomy which the New Jersey Attorney General possesses,[13] and the role which former New Jersey Attorneys General had played in the toxic waste area[14] indicate that the New Jersey Attorney General is in a position to make recommendations and judgments informed by experience in toxic waste issues.

When the Study Group met at the Justice Department in Washington on June 8 of 1981, it immediately and unanimously voted one of its members, the co-author, Professor Frank Grad, as Reporter for the Superfund section 301(e) Study Group.[15] The vote then took place for Chairman, a critical position in that the Chairman would be expected to provide focus to the deliberations on controversial questions. The difficulty of achieving agreement within the Group became apparent from the first, when the meeting deadlocked three times in the vote for a Chairman. After the third vote, the other co-author happened to leave the room for a few minutes, and upon his return, was advised by the Study Group that he was the compromise choice as Chairman. He remained in that position in spite of his reluctance to assume the responsibility because he had only assumed the Office of Attorney General a few weeks earlier and had not as yet had the opportunity to gain a sound familiarity with the field.

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[12] *See* N.J. Dep't of Envtl. Protection, Hazardous Waste Management in N.J. 3 (1982) (over 350 hazardous waste sites in New Jersey); Office of Water and Waste Management, U.S. Envtl. Protection Agency, Everybody's Problem: Hazardous Waste (1980) (Environmental Protection Agency estimates that New Jersey generates more hazardous waste than any other state); Hazardous Waste Advisory Comm'n Report to Governor Brendan Byrne 11 (1980) (approximately 10,000 generators of hazardous waste in New Jersey). *See generally* English, *Hazardous Waste Regulation: A Prescription For Clean Water*, 13 Seton Hall L. Rev. 229 (1982).

[13] N.J. Const. art. 5, § 4, para. 3 (creation of executive branch of government which includes nonelected Attorney General); *see* N.J. Stat. Ann. §§ 52:17A-4, :17B-4 (West 1970); *see also* Alexander v. New Jersey Power & Light Co., 21 N.J. 373, 380, 122 A.2d 339, 334 (1956); Keenan v. Essex County Bd. of Chosen Freeholders, 105 N.J. Super. 271, 280-81, 251 A.2d 785, 789-90 (Law Div. 1968).

[14] Attorneys General from this jurisdiction, in particular William F. Hyland, former President of the National Association, and John J. Degnan, have established a reputation for activism with the Association, especially with reference to toxic waste problems. This tradition continues under current Attorney General Irwin I. Kimmelman.

[15] Professor Grad, as law teacher and Director of the Columbia University Legislative Drafting Research Fund, has taught and written in the fields of environmental and public health laws. Additionally, he has amassed close to thirty years experience in legislative research and policy studies.

The Study Group began its task by requesting the Reporter to prepare an outline of likely issues and problems encountered in the assertion of claims from injury arising from exposure to hazardous wastes. The discussion of these problems occupied the first several meetings of the Group. In the early stages of the Study, the Reporter and his staff at the Legislative Drafting Research Fund prepared numerous legal memoranda on available legal remedies and obstacles to recovery under both statutory and common law.[16] The discussion of such memoranda often suggested the need for further research, which would then be submitted to the Group members in advance of the next meeting. In the fall of 1981, based on Study Group discussions, the Reporter began to submit proposed segments of the final report to the Study Group for their consideration and analysis. In some instances, members of the Group prepared suggested revisions and redrafts of their own, to be discussed along with the Reporter's submissions. The process was detailed and thorough, and it is fair to say that no part or word of the final report escaped the detailed and critical review of the membership.[17]

As the preceding account of the procedures of the Study Group indicates, there was much opportunity for dialogue and debate. The debate was often intense, and sometimes heated, but invariably fruitful. The quality of the membership of the Group was exceptionally high, and though the individual members of the Group held strong convictions on a variety of subjects, they were also good lawyers, capable of compromise and yielding to persuasion. Although it is likely that no member of the Group concurred with the Report in its entirety, it is important to note that the Study Group, in spite of its diversity, managed to agree on most major recommendations, as well as on most matters of detail. While a number of members felt compelled to submit separate "Comments"[18] to the Report, these comments were generally concerned with specific aspects of the Report and did not dissent from the core of the two-tier remedial proposal.[19]

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[16] A major portion of the research memoranda is produced in REPORT, *supra* note 9, app. A-O.

The authors wish to acknowledge the assistance rendered by Patricia A. Porter, Associate Director of the Legislative Drafting Research Fund of Columbia University, and the student researchers whose names are referred to in REPORT, *supra* note 9, at 1. The authors also wish to acknowledge the assistance rendered to the Study Group by Edwin Stier, former Director of the New Jersey Division of Criminal Justice.

[17] The Study Group held meetings in different locations in the United States so as to facilitate as full attendance as possible. *See id.* at 19.

The Report of the Study Group, entitled *Injuries and Damages from Hazardous Wastes—Analysis and Improvement of Legal Remedies*, was transmitted on July 1, 1982, to Vice-President Bush, as President of the Senate, and Thomas P. O'Neill, Jr., as Speaker of the House.[20] It attempts to remain faithful to its congressional mandate, i.e., the study and analysis of available causes of actions for the recovery for personal injuries and property and environmental damage resulting from the exposure to hazardous waste, the examination of the adequacy of available remedies, and existing barriers to recovery, concluding with appropriate recommendations to the Congress. This Article will focus on the essential findings and recommendations of the Report. We will first summarize the findings and then restate the most significant portions of the recommendations.

II. Dimension and Complexity of Hazardous Waste Problem

The discussion of legal issues relating to injuries from hazardous wastes must proceed in a setting of factual and legal uncertainty.[21] Despite these uncertainties, the Study Group advised that a three step process be undertaken to assess the magnitude of the problem: 1) location of hazardous waste dump sites, 2) analysis of the contents of these sites, and 3) evaluation of the likelihood of exposure and injury from the sites.[22]

Currently, there are widely differing estimates on the number of sites that contain hazardous wastes.[23] These estimates range from a low of 4,802 sites, based on an industry sponsored study, to a high of 50,000 sites, based on a Government sponsored study.[24] Several factors contribute to the difficulty in achieving a consensus on site identification. For example, not only have sites been abandoned,[25] but there are inadequate records on past disposal practices.[26] Thus, some dumps may only be discovered by accident, others may never be discovered.[27]

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[18] *Id.* at 7; *see infra* note 19.

[19] *See* Report, *supra* note 9, at 284-359. Even the two most critical comments supported the establishment of an administrative compensation remedy while preserving an opportunity for recourse to plenary common law actions. *See id.* at 295, 299 (comments of Charles D. Breitel); *id.* at 305, 308-10, 321-25 (comments of George C. Freeman, Jr.).

[20] Letter from Study Group to the Hons. George Bush and Thomas P. O'Neill (July 1, 1982), *reprinted in* Report, *supra* note 9, at 3 (giving brief description of format of Report).

[21] The uncertainty of the inquiry is increased by the fluctuating definitions of hazardous wastes and substances. Further complications are possible because the definitions differ for purposes of providing regulatory standards and allowing individual compensation. Report, *supra* note 9, at 24-25.

[22] *Id.* at 25.

[23] *Id.* at 21-22.

Once a site is identified, analyzing the contents of the site presents additional barriers, because there are limitations inherent in the sampling process itself.[28] Since there exists a danger of substance release during sampling, only a finite number of samples can be taken.[29] These samples, therefore, may not reflect the contents of the entire site and thus, may not always prove accurate.[30] Moreover, present testing procedures cannot identify all chemicals and chemical byproducts.[31] Concurrently, determination of the level of toxicity to humans erects yet another obstruction in site identification.[32] Adverse health effects may not appear for fifteen or twenty years or longer because of the long latency period which is often present.[33] If, during this latency period, an individual is exposed to other toxic substances, the causal link between the adverse health effects and any one hazardous substance is put into issue.[34] It is also possible that different wastes at one site will react synergistically to create a compound more toxic than any of the substances on their own.[35]

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[24] *Id.* at 21. Chemical Manufacturer's Association (CMA) produced the low figure on the basis of a phone survey of state environmental agencies. *Id.* at 22. The CMA report provides no information on the method used by states to arrive at their reported figures, or whether the states submitted preliminary or final data. *Id.* Fred C. Hart Associates compiled the high estimate as a result of a study from EPA regional office reports. *Id.* The data collection resulted, primarily from an extrapolation of figures relative to only 232 sites combined with information on annual national output of hazardous waste. *Id.* Thus, both sets of figures are subject to serious doubt. *Id.*

[25] *Id.* at 25; *see* Subcomm. on Oversight and Investigation, House Comm. on Interstate and Foreign Commerce, 96th Cong., 1st Sess., Waste Disposal Site Survey, XXIV (Comm. Print 1979) [hereinafter cited as Subcomm. Site Survey].

[26] Report, *supra* note 9, at 25-26. In a survey of the 53 largest chemical companies, on the average, most records dated back only to 1968. Subcomm. Site Survey, *supra* note 25, at XIII. *See generally* Maugh, *Just How Hazardous Are Dumps?*, 215 Science 490 (1982).

[27] Report, *supra* note 9, at 26; *see* Langner, *Hazardous Wastes: Ghosts of a Prodigal Past*, 82 Tech. Rev. 10 (1980) (industrial waste site containing substances dating back 100 years discovered during land development excavation).

[28] Report, *supra* note 9, at 26; *see also* Senate Comm. on Env't and Public Works, 96th Cong., 2d Sess., A Report From the Surgeon General and a Brief Review of Selected Envtl. Contamination Incidents with a Potential for Health Effects 24-25 (Comm. Print 1980). [hereinafter cited as Report from Surgeon General].

[29] Report, *supra* note 9, at 24.

[30] *Id.* at 45-50; *see Love Canal: Health Studies and Relocation Joint Hearings Before the Subcomm. on Oversight and Investigations of the House Comm. on Interstate and Foreign Commerce and the Subcomm. on Environment, Energy and Natural Resources of the House Comm. on Government Operations*, 96th Cong., 2d Sess. 32-33 (1980) (state-of-the-art insufficient to detect effects of hazardous waste disposal on human health).

[31] Report, *supra* note 9, at 45-50.

[32] *Id.* at 23. The level of the toxicity increases, for example, as the level of the substance increases in terms of quantity present at a site. Thus, " 'virtually all substances become toxic at sufficiently high levels.' " *Id.* (quoting Senkan & Stauffer, *What To Do With Hazardous Waste*, 84 Tech. Rev. 34, 40 (1981)).

Once identification and analysis is completed, the final process involves evaluation of the likelihood of exposure and injury.[36] In conducting the evaluation it is necessary to examine several methods of exposure, including "direct contact, fire and explosion, groundwater contamination via leachate, surface water contamination via runoff or overflow, air pollution via open burning, evaporation and wind erosion and poison via the food chain."[37] Groundwater seepage is the most common mode of human exposure.[38] The determination of the path followed by pollutants in underground water is difficult and uncertain and prediction of the movement of underground plume of hazardous waste is equally unreliable.[39] Further, drilling of test wells for monitoring creates the risk of further aquifer contamination.[40] Monitoring for exposure becomes even more difficult because the base line concentrations of chemical substances are already high in certain population areas.[41] The scientific problem of estimating the number of victims is so great because the uncertainties multiply at each step of the process of determining the number of persons exposed and the causal link between exposure and injury.

It seems that government and scientific sources agree that it will be impossible to produce an accurate estimate of the number of hazardous waste injuries likely to emerge until more accurate information is gathered about the scope of the hazardous waste problem in general, and until scientific advances produce more concrete information about the relationship between exposure and injury. In spite of strong efforts by the Study Group, little data, or even estimates, could be obtained on the actual number of persons exposed or the true magnitude of risk for serious injury and disease. Congress faced a similar situation during enactment of CERCLA. Just as Congress acted to protect against uncertain risks of injury, policy makers will need to make similar decisions on an assessment that is largely unquantifiable.

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[33] *Id.*

[34] *Id.*

[35] *Id.* The Study Group noted the importance in developing epidemiological studies capable of accurately assessing these unknown substances. *Id.* at 24 & n.18; *see* REPORT FROM SURGEON GENERAL, *supra* note 28, at 28-35.

[36] REPORT, *supra* note 9, at 27.

[37] *Id.* (quoting Hazardous Waste Fact Sheet, ENVTL. PROTECTION J., Feb., 1979, at 12)).

[38] *Id.* at 28. *See generally* U.S. COUNCIL ON ENVTL. QUALITY, CONTAMINATION OF GROUNDWATER BY TOXIC ORGANIC CHEMICALS (1981); R. DEWIEST, GEOHYDROLOGY 165-68 (1965).

[39] REPORT, *supra* note 9, at 29.

[40] *Id.*

[41] *See* Maugh, *supra* note 26, at 492-93.

III. ANALYSIS OF EXISTING LEGAL REMEDIES AND BARRIERS TO RECOVERY

A. *Recurring Problems and Barriers*

The Study Group analyzed available common law and statutory remedies in considerable detail, drawing both on federal and state legal sources and authorities. In analyzing legal remedies for injuries and damages caused by hazardous wastes, the Study Group followed the direction of the Superfund and thus focused on remedial measures for releases of hazardous substances into the environment through wastes and spills.[42] Accordingly, the remedies discussed in the Report are limited to damages for personal injury, environmental damage, and property damages resulting from the spills of hazardous substances and improper disposal of hazardous waste.

The Study Group first focused on recurring problems that face an injured plaintiff regardless of the cause of action selected. These problems include the statute of limitations, the joinder or combination of parties, and the proof of causation. The statute of limitations presents a potential pervasive bar to recovery[43] in states which have not adopted a discovery rule. States applying a liberal discovery rule postpone accrual of the action until the plaintiff discovers or reasonably should have discovered the injury.[44] In the absence of a rule, the action accrues and the statute begins to run at the time of injury.[45] Since most personal injuries resulting from toxic waste exposure have a long latency period,[46] plaintiffs residing in states without a discovery rule may lose the right to bring a lawsuit before they learn of their injuries.[47] Determining the liability of defendants[48] and the appropriateness of joinder of defendants[49] are problems peculiar to the hazardous waste injury claims. During the long latency period of the injury,[50] use or ownership of the site is likely to have changed. Thus, the issue whether the present owner or user is responsible for the effects of conditions caused by an earlier owner or user needs to be resolved.[51] An inquiry arising from this problem is among whom should liability be apportioned.[52] Because a plaintiff will oftentimes be unable to identify which of several owners or users has contributed to his injury,[53] it is likely that the plaintiff will lose his case unless a theory of joint liability is adopted,[54] or unless the burden of proof is shifted to the defendants to show which one caused the injury.[55]

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[42] *Compare* REPORT, *supra* note 9, at 41 ("emphasis of this report . . . is on remedying the adverse consequences of improper disposal, improper transportation, spills, and improperly maintained or closed disposal sites") *with* Comprehensive Environmental Response, Compensation and Liability Act of 1980, Pub. L. No. 96-519, 94 Stat. 2767 (introductory statement) (purpose of Act is "[t]o provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites").

[43] "Statutory limitations periods are "designed to promote justice by preventing surprises through the revival of claims that have been allowed to slumber until evidence has been lost, memories have faded, and witnesses have disappeared. The theory is that even if one has a just claim it is unjust not to put the adversary on notice to defend within the period of limitation and that the right to be free of state claims in time comes to prevail over the right to prosecute them." American Pipe & Constr. Co. v. Utah, 414 U.S. 538, 554 (1974) (quoting Order of R.R. Telegraphers v. Railway Express Agency, Inc., 321 U.S. 342, 348-49 (1944)). *See generally* McGovern, *Toxic Substances Litigation in the Fourth Circuit*, 16 U. RICHMOND L. REV. 247 (1982).

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[44] REPORT, *supra* note 9, at 43-44; *see, e.g.*, S.C. CODE ANN. § 15-3-535 (Law. Co-op Supp. 1980). Variations of the discovery rule include postponing accrual of the action until the plaintiff ascertains or reasonably should have ascertained the causal connection between the injury and exposure to the hazardous substance, *e.g.*, Warrington v. Charles Pfizer & Co., 274 Cal. App. 2d 564, 80 Cal. Rptr. 130 (Ct. App. 1969), or until the plaintiff realizes that he has a cause of action. *E.g.*, City of Miami v. Brooks, 70 So. 2d 306 (Fla. 1954); Lopez v. Sawyer, 62 N.J. 267, 300 A.2d 563 (1973).

[45] *See* REPORT, *supra* note 9, at 43.

[46] *See supra* note 23 and accompanying text.

[47] *See* REPORT, *supra* note 9, at 43.

[48] Proving causation is a plaintiff's most serious obstacle in establishing a defendant's liability. *See infra* notes 61-68 and accompanying text.

[49] A victim of hazardous waste exposure generally has a cause of action against one or more of the following: the disposer, the owner or lessee of land on which the hazardous condition exists, or a class of persons deemed responsible for the creation of the hazard. REPORT, *supra* note 9, at 46.

[50] *See supra* note 33 and accompanying text.

[51] REPORT, *supra* note 9, at 46.

[52] The general rule has been that a current owner not responsible for the condition is liable to injured parties if he knew or should reasonably have known of the condition on the land. RESTATEMENT (SECOND) OF TORTS § 373 (1965); *id.* § 804A (1979). The trend, however, is towards limiting the liability of current owners unless that owner associates himself with the maintenance or creation of the condition. *E.g.*, Philadelphia Chewing Gum Corp. v. Commonwealth, 35 Pa. Commw. 443, 387 A.2d 142 (Commw. Ct. 1978), *aff'd sub nom.* National Wood Preserver v. Commonwealth, 489 Pa. 221, 414 A.2d 37 (1980). A few states have enacted legislation imposing liability on a subsequent landowner not responsible for creating a nuisance but who fails to abate the hazardous condition. *See* CAL. CIV. CODE § 3483 (West 1980); IDAHO CODE § 52-109 (Bobs Merrill 1981); *see also* REPORT, *supra* note 9, at 46-53.

[53] *See supra* notes 49-51 and accompanying text.

Joinder of similarly situated plaintiffs[56] solves problems which arise in hazardous waste litigation. Because of the complexities inherent in hazardous waste cases,[57] the cost of pursuing an action erects a substantial barrier to a plaintiff's recovery. Joinder of plaintiffs reduces the cost of litigation to individual plaintiffs and avoids inevitable trial delays resulting from a large number of claims and repetitive presentation of medical and scientific evidence.[58] Several procedural devices may be employed for joinder of plaintiffs,[59] but these devices are not uniformly available.[60]

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[54] *See, e.g.*, Cal. Health & Safety Code § 25363 (b) (West 1980); N.C. Gen. Stat. § 143-215. 94 (1978) (only statutes providing for apportionment among all persons controlling, causing, or contributing to discharge of hazardous wastes).

[55] *See* Report, *supra* note 9, at 39. At common law, to maintain an action the plaintiff has the burden of proving that it is more likely than not that the conduct of the defendant was a substantial factor in bringing about the injurious result. *See* W. Prosser, Law of Torts § 64, at 414-15 (4th ed. 1971). States have adopted different theories of liability which shift the "burden of apportionment." *See* Report, *supra* note 9, at 54-56. The concert of action theory holds that a party is liable if he performs tortious acts with others in pursuit of a common goal. *See* Restatement (Second) of Torts § 876(a) (1979). The conduct of the parties can imply an agreement, and parties properly joined under the theory are jointly and severally liable for damages to the plaintiff. *Id.* § 876(a) comment a. Under the theory, all defendants are jointly and severally liable for the plaintiff's injuries, and the burden switches to the individual defendants to prove their lack of responsibility for the injury. Report, *supra* note 9, at 56-58; *see* Restatement (Second) of Torts § 433B(2), (3) (1965). Alternative liability may be especially useful in hazardous waste cases in which several parties cause an injury that is theoretically apportionable but in reality indivisible, *see* Borel v. Fibreboard Paper Prods. Corp., 493 F.2d 1076 (5th Cir. 1974), or in a situation in which several tortfeasors were involved in an action but only one did in fact cause injury. *See* Summers v. Tice, 33 Cal. 2d 80, 199 P. 221 (1948). A problem with alternative liability is that it will not be applied unless all potential defendants are joined. Report, *supra* note 9, at 59; *see* Namm v. Charles E. Frosst & Co., 178 N.J. Super. 19, 31-32, 427 A.2d 1120, 1127-28 (App. Div. 1981).

A fourth theory, market share liability, is also similar to alternative liability. Market share liability does not require the defendants to have acted in concert, and switches to the defendants the burden of proving no responsibility for the plaintiff's injuries. *See* Sindell v. Abott Laboratories, 26 Cal. 3d 605, 607 P.2d 933, 163 Cal. Rptr. 140 (1980). Unlike alternative liability, however, all potential defendants need not be joined (only a substantial percentage of the market need be joined) and the defendant's liability would be limited to the percentage of the market of the hazardous material held by the particular defendant. Report, *supra* note 9, at 63-64. It is important to note, however, that the cause of action under which a plaintiff brings suit may affect whether a particular apportionment theory is applicable. *Id.* at 56 For a more detailed discussion of the four theories of apportionment of liability, see *id.* at 53-66.

[56] The issue of joining proper plaintiffs is less complex than proper parties defendant because the definition of the chosen cause of action generally defines who may recover in the action. *See* Report, *supra* note 9, at 67. Moreover, while the precise nature of injury may differ, elements of exposure or causation are generally similar enough to satisfy the "commonality of interest" requirement of joinder. Fed. R. Civ. P. 20; *see* Report, *supra* note 9, at 67-68.

[57] *See supra* notes 21-43 and accompanying text.

A major recurring issue, regardless of the particular cause of action, is that of proof of causation. The plaintiff must prove in each case that there is a causal nexus between the injury and the environmental condition for which the defendant is allegedly responsible.[61] The issue of proof of causation is rendered more difficult by a number of recurring circumstances. In the case of exposure to a hazardous waste disposal site, the plaintiff may find it difficult to pinpoint responsibility because the site has usually received a variety of hazardous wastes from a variety of sources over an extended period of time.[62] The problem will be rendered even more complicated because of the long latency periods frequently associated with injuries from hazardous waste exposures.[63] During a ten-to-forty year latency period, the site may have changed ownership several times—and the plaintiff too has probably moved about to different locations, thereby potentially exposing himself to a variety of other environmental influences or toxic exposure.[64] Proof of causation will require large amounts of sophisticated medical and scientific testimony to demonstrate the epidemiologic or statistical correlation between certain diseases and certain environmental exposures. The nature of the exposure itself—whether by air, water, ingestion, inhalation or other contact—may require testimony, so as to show that the kind of exposure, its duration or frequency, and its intensity, could or did produce the kind of disease or injury suffered by the plaintiff. Medical testimony on the etiology of the disease is necessary to show how the particular substance caused the condition in issue.[65] Reliance on Government data[66] and creation of rebuttable presumptions such as those that exist under workers' compensation[67] may eventually serve useful probative purposes.[68] It is clear, however, that proof of the causal connection between exposure and injury is an almost overwhelming barrier to recovery, particularly in smaller cases (regardless of their merit) because the cost of mounting the massive probative effort and the arrays of technical and scientific evidence will be prohibitive.

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[58] REPORT, *supra* note 9, at 52-53. The cost of securing expert medical and scientific testimony necessary to prove causation is expensive and may be prohibitive to a single plaintiff. *See infra* note 46; *see also* Beshada v. Johns-Manville Prods. Corp., 90 N.J. 191, 447 A.2d 539 (1982).

[59] Federal rules (or analogous state rules) provide for voluntary joinder of parties sharing a "commonality of interests." FED. R. CIV. P. 20, and for the consolidation of similar actions for joint trial. FED. R. CIV. P. 42(a). Another approach to joinder of parties is the offensive use of collateral estoppel. *See, e.g.*, Hart v. American Airlines, Inc., 61 Misc. 2d 411, 304 N.Y.S.2d 810 (Sup. Ct. 1969).

Additionally class actions have been used in pollution cases. *See, e.g.*, Pruitt v. Allied Chem. Corp., 85 F.R.D. 100 (E.D. Va. 1980) (toxic pollution of Chesapeake Bay); Biechele v. Norfolk & W. Ry., 309 F. Supp. 354 (N.D. Ohio 1969) (coal dust air pollution). A majority of the Group, however, maintained that the class action device is inappropriate in mass tort claims seeking damages for personal injuries. REPORT, *supra* note 9, at 68; *see* Yandle v. PPG Indus., 65 F.R.D. 566 (E.D. Tex. 1974) (class action inappropriate for massive tort claim because common questions did not predominate over uncommon questions and different legal theories advanced by plaintiffs and defendants); *see also* Note, *Mass Accident Class Actions*, 60 CALIF. L. REV. 1615 (1972). For a general discussion of class actions in the context of mass toxic torts, see REPORT, *supra* note 9, app. N, at 1-41.

[60] *See* REPORT, *supra* note 9, at 53-54.

[61] *See* RESTATEMENT (SECOND) OF TORTS § 430 (1965).

[62] See *supra* notes 25 & 26 and accompanying text.

[63] REPORT, *supra* note 9, at [illegible] another difficulty in proving causation is the plaintiff's possible exposure to several ha[illegible] environmental conditions, thus making it difficult to pinpoint which exposure caused t[illegible]. *Id.*

[64] See *supra* notes 35-37 and accompanying text.

B. *Available Statutory and Common-Law Causes of Action*

The Study Group examined virtually all federal and state statutory remedies and all common-law tort remedies available to private plaintiffs.[69] It found no federal statutes which expressly provide remedies for personal injury due to hazardous waste exposure in non-occupational settings.[70] Federal legislation does provide limited sources of funding for personal injury and property damage incurred as a result of environmental pollution, generally in the form of trust funds[71] or regulations requiring evidence of financial responsibility including liability insurance from owners and operators of hazardous waste disposal facilities.[72] Reliance on the federal common law of nuisance is severely limited in light of recent Supreme Court decisions holding that comprehensive water pollution control legislation preempted the federal common law of nuisance.[73] Moreover, following *Middlesex County Sewerage Authority v. National Sea Clammers Association*,[74] there is no basis for reliance on implied private rights of action derived from federal pollution control statutes.

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[65] REPORT, *supra* note 9, at 70-71; *see supra* note 58 and accompanying text; *see also* REPORT FROM SURGEON GENERAL, *supra* note 28.

[66] Various Government agencies collect scientific data in connection with the Federal Insecticide, Fungible, and Rodenticide Act, 7 U.S.C. §§ 135-136 (1976 & Supp. V 1981); the Toxic Substances Control Act, 15 U.S.C. §§ 2601-2629 (1976 & Supp. V 1981); the Federal Food, Drugs and Cosmetic Act, 21 U.S.C. §§ 301-392 (1976 & Supp. V 1981); the Occupational Health and Safety Act, 29 U.S.C. §§ 651-678 (1976 & Supp. V 1981); and the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901-8987 (1976 & Supp. IV 1980).

[67] In workers' compensation cases, for example, the burden of proof to show that the claimant's injury did not arise at his employment is shifted to the defendant. *See, e.g.*, Rayford v. National Union of Hosp. & Nursing Home Employees, 56 A.D.2d 975, 394 N.Y.S.2d 738 (1977) (mem.).

[68] *See* REPORT, *supra* note 9, at 71.

[69] *Id.* at 72-117.

[70] *Id.* at 72-75.

[71] *See* 42 U.S.C. §§ 9611-9614, 9631-9641 (Supp. IV 1980).

State statutes creating a private right of action for damages caused by hazardous waste are rare. Only four states have enacted legislation establishing this cause of action,[75] while only one state has eased the plaintiff's burden of proof for causation.[76] Statutory causes of action for property damages resulting from hazardous waste disposal are equally restricted.[77] In a few states, relief is available from a fund established by hazardous waste legislation.[78] Two states have enacted legislation requiring operators and owners of hazardous waste sites to be able to compensate private parties who incur damages from hazardous waste disposal.[79]

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[72] CERCLA, Pub. L. No. 96-510, § 108(b)(1), 94 Stat. 2767, 2786 (1980) (codified at 42 U.S.C. § 9608(b)(1) (Supp. IV 1980)); Resource Conservation and Recovery Act of 1976 (RCRA); Pub. L. No. 94-580, § 3004, 90 Stat. 2795, 2807-08 (codified at 42 U.S.C. § 6924 (1976)).

[73] Report, *supra* note 9, at 87; *see* Middlesex County Sewerage Auth. v. National Sea Clammers Ass'n, 453 U.S. 1 (1981); Milwaukee v. Illinois, 451 U.S. 304 (1981).

[74] 453 U.S. 1 (1981) (refusal to imply private cause of action absent contrary congressional intent when environmental statute expressly provides particular remedy).

[75] Alaska has adopted legislation which holds a party controlling hazardous substances strictly liable for damages caused whenever the substance enters the property of another. Alaska Stat. § 46.03.824 (1980). North Carolina's legislation holds parties strictly liable for damages caused by discharge of hazardous materials into the state's waters. N.C. Gen. Stat. §§ 143-215.77(18), 143-215.93 (1980). North Dakota and Rhode Island have adopted a negligence per se approach which imposes liability on parties for hazardous waste damage when the parties acted in violation of states environmental laws. N.D. Cent. Code § 32-40-06 (1980); R.I. Gen. Laws § 23-19.1-22 (1980).

[76] Pennsylvania's solid waste management statute establishes a rebuttable presumption of causation for "all damages, contamination or pollution within 2500 feet of the perimeter of the area where the hazardous waste activities have been carried out." Pa. Stat. Ann. tit. 35, § 6018.611 (Purdon Supp. 1982)).

[77] The four state statutes which create a cause of action for personal injuries resulting from hazardous waste disposal are equally applicable in claims seeking relief for property damage. *See supra* note 76. In addition to these four jurisdictions, Maine and Massachusetts have enacted legislation establishing a cause of action which is limited to claims for property damage resulting from hazardous waste disposal. Me. Rev. Stat. Ann. tit. 38, § 1306-C(5) (Supp. 1981); Mass. Ann. Laws ch. 21, § 27(14) (Michie/Law Co-op 1981). The Pennsylvania law easing the plaintiff's burden of proof in personal injury actions also applies to property damage actions. *See supra* note 76. A Massachusetts statute which has a similar provision easing a plaintiff's burden of proof of causation is limited to actions for property damage. Mass. Ann. Laws ch. 21C, § 10 (Michie/Law Co-op 1980).

[78] For example, New Jersey has established a fund designed to pay for the cleanup of hazardous waste discharge which provides that "the fund shall be strictly liable . . . for all . . .

Even if a state does not expressly create a private right of action, a plaintiff may rely on hazardous waste statutes as a vehicle for state courts to imply a cause of action against defendants found to be in violation of state hazardous waste laws.[80] Even if a court refuses to imply a private cause of action, it may find that a violation of a statutory standard establishes negligence per se.[81] Finally, absent a preemptive environmental statute, a number of states grant a private cause of action under state public nuisance laws.[82]

An examination of statutory remedies reveals that there is virtually no possibility of an effective private cause of action brought on the basis of a pollution control statute. Therefore, to recover for hazardous waste injuries, a plaintiff must currently rely on common-law tort causes of action. The Report examines these actions, including negligence, trespass, private and public nuisance actions, and strict liability.[83] It finds that all of them have some useful applications in suits for hazardous waste injuries—subject, however, to the usual barriers of proof of causation, statute of limitations, and allocation and apportionment of liability.

A private action for negligence could arise out of the improper disposal of hazardous wastes, improper transportation of such wastes,

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damages" caused by the discharge. N.J. STAT. ANN. § 58:10-23.11g (a) (West 1982); *accord* FLA. STAT. ANN. § 403.725(1) (West Cum. Supp. 1983) (establishing fund to pay for property damage caused by hazardous waste disposal).

[79] FLA. STAT. ANN. § 403.724(1), (3) (b)-(d) (West Cum. Supp. 1981); OKLA. STAT. ANN. tit. 63, § 1-2008(B) (West Cum. Supp. 1982-1983). Eleven other states require some evidence of financial responsibility, however, only five of these states require finances to be available for liability, and "liability" is left largely undefined. *E.g.*, MISS. CODE ANN. § 17-17-27(1)(h) (Cum. Supp. 1982). *See generally* REPORT, *supra* note 9, app. E, at 4-5.

[80] REPORT, *supra* note 9, at 90; *cf.* Sherman v. Field Clinic, 74 Ill. App. 3d 21, 28-29, 392 N.E.2d 154, 161 (App. Ct. 1979) (finding implied cause of action against defendant violative of state debt collection statutes).

[81] *See* Orthopedic Equip. Co. v. Eutsler, 276 F.2d 455 (4th Cir. 1960) (violation of duty created by Federal Food, Drug, and Cosmetic Act is negligence per se under Virginia common law); Freeman v. Olin Corp., CV 80-M-5057 (N.D. Ala. Aug. 14, 1981) (violation of duty created by Alabama Pesticide Act establishes claim of negligence per se); *see also* W. PROSSER, *supra* note 55, § 36, at 200-04. Some jurisdictions held that violations of statutory standards merely establish some evidence of negligence. *Id.* § 36, at 201; *see also* Morris, *The Relation of Criminal Statutes to Civil Liability*, 46 HARV. L. REV. 453 (1933).

[82] For a list of the states granting a private cause of action under a public nuisance statute, see REPORT, *supra* note 9, app. H, at 18-19. Five states limit a plaintiff's remedy to abatement of the nuisance. *Id.* app. H, at 20.

[83] *Id.* at 96-132. *See generally* F. GRAD, TREATISE ON ENVIRONMENTAL LAW § 4A.05 (1981).

the occurrence of negligently caused spills, and the negligent contamination of water.[84] Negligence focuses on conduct in breach of a duty of due care rather than on conditions.[85] Thus, to establish a cause of action in negligence, one must show that the defendant was under a duty to conform to a standard of conduct, that he breached the established duty, that the conduct was the proximate cause of the injury, and that the plaintiff suffered actual loss or damage.[86]

The cause of action for trespass has some significant applications in private actions involving air pollution and runoff of liquid wastes or contamination of groundwater. The nature and characteristics of trespass, however, belie its effectiveness as a remedy in hazardous waste cases. Trespass requires an invasion with another's exclusive possessory interest in land.[87] Thus, if the injury is unrelated to the invasion of property or if the plaintiff is not in possession of the property, he cannot sue in trespass. In addition, the defendant must intentionally, negligently, or as a result of hazardous activity cause the interference with another's property.[88]

A private nuisance is an unreasonable interference with a plaintiff's use and enjoyment of his land.[89] The resolution of private nuisance cases requires a balancing of the equities, i.e., a weighing of the plaintiff's interest against the social and economic utility of the defendant's activities which cause the interference.[90] A private plaintiff may sue for damages flowing from a public nuisance, defined as an unreasonable interference with a general right of the public,[91] only if his injury differs in kind from that suffered by the general public.[92]

The Study Group concluded that strict liability for injury due to hazardous waste is the most viable theory of recovery because of the dangerous nature of hazardous waste disposal.[93] Widespread acceptance of strict liability in theory, however, has not meant uniform application of the principle.

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[84] Report, *supra* note 9, at 97.

[85] W. Prosser, *supra* note 55, § 31, at 145.

[86] *Id.* § 31, at 143.

[87] *Id.* § 13, at 69.

[88] Restatement (Second) of Torts §§ 158, 165 (1965). *But see* Report, *supra* note 9, app. I, at 1-2 (discussing advantages of trespass cause of action).

[89] Restatement (Second) of Torts § 821D (1979); *see, e.g.*, King v. Columbia Carbon Co., 152 F.2d 636 (5th Cir. 1945).

[90] Boomer v. Atlantic Cement Co., 26 N.Y.2d 219, 256 N.E.2d 870, 309 N.Y.S.2d 312 (1970).

[91] Restatement (Second) of Torts § 821B (1) (1979).

[92] *Id.* § 821C(1).

[93] Report, *supra* note 9, at 110, 130.

Four general strict liability formulations have developed among the several states. Each formulation focuses on different factors in a strict liability inquiry.[94] An early formulation of the doctrine, strict liability for a "non-natural" use of land, considered the appropriateness of the activity by reviewing the manner and relationship of the activity to its surrounding.[95] Courts applying this formulation must, therefore, balance the competing interests of the parties. Courts also engage in balancing in cases decided under a second formulation of strict liability—the "ultrahazardous" doctrine of the *Restatement*.[96] This formulation, emphasizing unavoidable risk and unusual usage, shifts the focus of the inquiry from the locale of the activity to the dangerous nature of the activity.[97] The *Restatement (Second)* formula of strict liability, adopting an "abnormally dangerous" activity test,[98] requires a balancing of numerous factors such as the utility of the activity, the foreseeability of harm, and the appropriateness of the locale of the activity.[99] The Study Group concluded that this form of strict liability takes on some of the characteristics of negligence. It also encourages a determination of liability on a case-by-case basis, which tends to complicate and prolong litigation.[100] A recent formulation of strict liability focuses on the "magnitude of the risk" of harm created by the activity.[101] Rejecting notions of fault, duty of care, and responsibility inherent in earlier formulas, this application concentrates on risks actually created, and not just risks and benefits known when the action occurred.[102]

The Study Group indicated its preference for a formulation of strict liability based on the magnitude of the risk, deemphasizing such elements as the locale of the activity or the foreseeability of harm relied on in alternative applications of the doctrine.[103] A magnitude of the risk theory seems especially appropriate in cases of hazardous waste disposal in which the risk is great and the environmental damage ubiquitous.[104]

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[94] *Id.* at 110.

[95] *See* Rylands v. Fletcher, L.R. 3 (H.L. 330) (1868) (original formulation of "non-natural" use doctrine).

[96] RESTATEMENT (SECOND) OF TORTS §§ 519-520 (1977).

[97] REPORT, *supra* note 9, at 116.

[98] RESTATEMENT (SECOND) OF TORTS §§ 519 comment b, 520 & comment a (1977).

[99] *Id.* § 520.

[100] REPORT, *supra* note 9, at 120.

[101] *See* New Jersey v Ventron Corp., No. C-2996-75 (N.J. Super. Ct. Ch. Div. Aug. 27, 1979), *modified and remanded*, 182 N.J. Super. 210, 440 A.2d 445 (App. Div. 1981).

[102] REPORT, *supra* note 9, app. K, at 12-13.

[103] *Id.* at 123.

The Study Group's analysis emphasized the application of strict liability to spread the costs of injury and to impose liability on those who economically benefit from the polluting activity[105] and who are in the best position to reduce or eliminate the risk.[106] As in the case of products liability, reliance on strict liability eases the economic burden on those harmed and provides greater predictability of liability.[107] The Report noted, however, that a theory of strict environmental liability does not resolve the problem of proof of causation,[108] and it is not at all clear that all states would impose strict liability for damages caused by hazardous waste.[109]

The Study Group concluded that although causes of action do exist for some plaintiffs under some circumstances, *a private litigant faces substantial barriers in an action for damages from hazardous waste exposure, particularly where the individual claims are small.*[110] The difficulty of recovery for valid claims is magnified by procedural barriers and by the cost of litigation, with proof of causation affecting every aspect of the litigation process.[111] Plaintiffs who are willing to undertake the major costs of litigation would be aided substantially by an easing of burdens in regard to causation, apportionment of damages, and statutes of limitations.[112] Persons with smaller claims, however, are unlikely to recover at all unless further steps are taken to reduce both legal and economic barriers to their recovery.[113] This supplies the basis for the Tier One compensation remedy recommended by the Study Group in Part IV of the Report.

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[104] *Id.* The Study Group noted that hazardous waste exposure most likely always causes some damage to humans and the environment: the only issue is how much damage. *Id.*

[105] *Id.*; *see* Beshada v. Johns-Manville Prods. Corp., 90 N.J. 191, 206-07, 447 A.2d 539, 547-48 (1982); Calabresi & Hirschoff, *Toward a Test for Strict Liability in Torts*, 81 YALE L.J. 1055, 1060 (1972).

[106] REPORT, *supra* note 9, at 124; *see* R. POSNER, ECONOMIC ANALYSIS OF LAW 1-10 (1972); W. PROSSER, *supra* note 55, § 75, at 495. *See generally* Calabresi, *Some Thoughts of Risk Distribution and the Law of Torts*, 70 YALE L.J. 499 (1961).

[107] REPORT, *supra* note 9, at 124.

[108] *Id.*

[109] *Id.* app. K, at 3.

[110] *Id.* at 130.

[111] *See id.* at 131.

[112] *Id.* at 132.

[113] *Id.*

IV. The Recommendations of the Superfund § 301(e) Study Group

To summarize the recommendations briefly, the Study Group issued a two-tier remedial proposal. The first step of the proposal, Tier One, provides no-fault compensation for personal injury resulting from hazardous waste, to be managed by the several states under a federal program.[114] This compensation plan, operating in a similar manner to workers' compensation, would provide full recovery for a person's medical expenses and, with certain limits, recovery for two-thirds of a person's loss of earnings. Death benefits for close surviving dependents would also be provided. In addition, injured persons would have the choice of proceeding with a personal injury claim under existing tort law, but the amount of any compensation award recovered by the claimant in Tier One must be deducted from, and be paid back out of, any judgment or settlement in a Tier Two plenary action.[115] A person electing to seek compensation under both tiers must repay the Tier One compensation award out of any payment obtained in the personal injury action. A person who recovers under both tiers would also be required to pay certain costs if the court found that the settlement or award in Tier Two did not substantially exceed the compensation award at Tier One. This provision is intended to avoid frivolous claims.[116]

A number of recommendations are addressed to the states to improve available tort remedies. Although the Proposal does not provide for no-fault compensation for private property and environmental damage under Tier One, the Study Group recommended that procedural and substantive improvements also be adopted in these actions. The Study Group further recommended that more Superfund monies be allocated for state cleanup of hazardous waste sites than has been available in the two years since passage of the Superfund legislation. Finally, the Group urges that more preventive measures be implemented to avoid the need for remedial action.

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[114] *Id.* at 193-254.

[115] While the Study Group unanimously recommended a two-tier approach, the difficult issue of access from Tier One to Tier Two was resolved by a 9 to 3 vote holding that recovery at Tier One should not bar access to Tier Two. *Id.* at 197-98. Alternatives such as binding election between the two tiers and unlimited access to both tiers were suggested by individual members. *Id.* at 200-01. The membership realized that a dual recovery scheme without limits would increase the cost to the system. A plaintiff with unlimited access to both systems would be free to gamble on a lawsuit after already recovering administrative compensation. *Id.* at 201-02. A number of members of the Group would have preferred to leave access to Tier Two to judicial discretion after compensation had been awarded at Tier One. *Id.* at 286-88 (Joint Statement of Messrs. Anderson, Breitel, Freeman & O'Connell).

[116] *Id.* at 198. If the action at Tier Two does not result in a judgment or settlement which exceeds the total amount of the compensation award by 25% or more, the judge would have the discretion to assess the costs of the action and expert witnesses against the plaintiff. *Id.* at 197-98.

The material which follows discusses the major aspects of the Group's Ten Recommendations. The Recommendations establish a two tier recovery system. The Second through Eighth Recommendations apply solely to Tier One compensation. The Ninth and Tenth Recommendations address Tier Two tort claims.

The Report's First and Second Recommendations establish a standardized method by which injury claims for hazardous waste exposures are intitiated. The Study Group recommended the Tier One compensation system in order to overcome the substantial obstacles faced by an injured person bringing a lawsuit, and in recognition of the present judicial system's inability to deal with a large number of claims. Tier One is a risk sharing system[117] operating somewhat like employment-related, workers' compensation insurance systems.[118] The proposed compensation system is clearly not work-related, however, and covers all persons exposed to hazardous wastes in a non-occupational manner.[119]

The Tier One remedy provides compensation without a showing of fault.[120] The administrative compensation plan is to be established by federal legislation,[121] but would mainly be operated by the states pursuant to federal law.[122] The purpose of the plan is to provide certain, though limited, compensation to meet the medical and economic needs of injured persons, in addition to a prompt method of recovery and cost allocation.[123]

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[117] *See infra* notes 138-42 and accompanying text.

[118] In New Jersey, for example, workers' compensation is funded by an industry wide contribution system. N.J. STAT. ANN. § 34:15-94 (West 1959), and an uninsured employer default assessment. *Id.* § 34:15-79.

[119] REPORT, *supra* note 9, at 209. The Study Group specifically recommended that forthcoming legislation expressly exclude injury due to occupational exposure. *Id.*; LARSON, THE LAW OF WORKMEN'S COMPENSATION § 65.10 (state statutory workers' compensation remedy intended as sole relief for occupational injury or disease). *See generally* Note, *Compensating Victims of Occupational Diseases*, 93 HARV. L. REV. 916 (1980) (overview of existing schemes for occupational disease victims).

[120] REPORT, *supra* note 9, at 196. Proposals have also been made for the use of no-fault rationale in other areas. *See, e.g.*, Ehrenzweig, *Compulsory "Hospital-Accident" Insurance: A Needed First Step Toward the Displacement of Liability for "Medical Malpractice,"* 31 U. CHI. L. REV. 64 (1964) (no-fault liability in medical field); O'Connell, *Expanding No-Fault Beyond Auto Insurance: Some Proposals*, 59 VA. L. REV. 749 (1973) (no-fault liability in products liability, medical malpractice, and other torts). *But see* Corboy, *The Expanding Universe of Jeffrey O'Connell: Backing Into A Brave New World*, 1976 U. ILL. L.F. 74.

[121] REPORT, *supra* note 9, at 240. The Report proposed that a federal agency be assigned the task of overseeing the state's compliance with the federal law. Suggested federal agencies included the Environmental Protection Administration and the Social Security Administration. *Id.*

[122] *Id.* at 206. This method is utilized throughout federal legislation. *See, e.g.*, Clean Water Act, 33 U.S.C. § 1342 (1976 & Supp. V 1981) (state implementation of National Pollutant Discharge Elimination System); Clean Air Act, 42 U.S.C. § 7410 (Supp. IV 1980) (state implementation plans for national primary and secondary ambient air quality standards).

The Tier One compensation system would cover injuries resulting from exposure to hazardous waste sites, improper transportation and spills, excluding occupational exposure covered under the workers' compensation system. The coverage of the plan would thus be coextensive with the coverage of CERCLA.[124] Compensation would be available both for exposure to old, or even abandoned "orphan" sites, for which no present opportunity for recovery exists, as well as to active or new sites.[125]

The Third Recommendation outlines a proposed filing process. The claimant must file the claim no later than three years after discovery of the injury,[126] so as to respond to the long latency periods of many hazardous waste injuries.[127] The provision would apply whether the discovery of the injury occurred before or after the effective date of the federal law that would establish the compensation plan. To establish a claim, the claimant must offer proof of exposure, proof of disease or injury, and proof of causation.[128] Proof of causation is to be eased considerably by reliance on appropriate rebuttable presumptions.

The Fourth Recommendation suggests adoption of two kinds of rebuttable presumptions. The first rebuttable presumption requires a showing that the defendant was *engaged* in a waste activity, the claimant was *exposed* to such waste, and the claimant *suffered* a resulting injury.[129] Upon proof that the claimant was *exposed to a waste and suffered injury which is known to result from such exposure*, the rebuttable presumption then arises that the exposure proximately caused the death, injury, or disease, and that the source of such exposure was responsible.[130] Presumptive proof that the injury is known to result from such exposure could also be demonstrated by reliance on Toxic Substance Documents, to be prepared by the federal agency authorized to administer the compensation system, on the basis of scientific data, and adopted in accordance with established administrative standards.[131] These documents would be relied on exclusively in a Tier One recovery.[132] Such a document could also be relied on to provide presumptive rebuttable proof of such other aspects of the disease as its disabling effect, likely duration and other consequences. The issue of the use of presumptions proved to be difficult and is discussed at great length in the Report, as it was by the Study Group.[133]

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[123] REPORT, *supra* note 9, at 206; *see infra* notes 141 & 142 and accompanying text.

[124] REPORT, *supra* note 9, at 207; *see supra* note 42 and accompanying text.

[125] REPORT, *supra* note 9, at 208.

[126] *Id.* at 209. The Study Group adopted the rule that the claim must be brought within three years after the disease or injury and its cause were discovered or reasonably should have been discovered. *Id.*

[127] *Id.*

[128] *Id.* at 209-10. Diagnostic proof can be aided through the use of the disease registry established under CERCLA, 42 U.S.C. § 4604(i) (Supp. IV 1980).

[129] REPORT, *supra* note 9, at 213-14.

[130] *Id.* at 214.

The Fifth Recommendation proposed that the compensation award provide full recovery of all reasonable medical expenses and an amount for loss earnings (*not* limited to wages or salary). Recovery would be limited to two-thirds of regular earnings, up to a limit set by Congress, suggested under current economic conditions at $2,000 per month, for as long as the disability continues.[134] The amount is to be reduced by collateral receipts from other public programs, such as Medicare and Medicaid.[135] Provision is also made for death benefits and injuries, such as genetic damage, that are not recognized under present tort law.[136] Pain and suffering, however, are not compensible under Tier One.[137] The compensation award recommended would fully compensate members of the public with incomes of $36,000 or less (after taxes). The purpose was to provide full compensation for persons below the level at which they would be likely to provide their own income protection by insurance. This would also have the result of disposing of more claims at Tier One rather than proceeding to Tier Two.

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[131] Toxic Substance Documents will be based upon scientific studies and incorporate information collected in connection with other federal regulations. Each document would be a compilation of evidentiary data on specific hazardous substance or waste and the health dangers each presents. The Group suggested inclusion of elements of exposure, the disease or diseases resulting from exposure, and independent factors related to exposure and disease. *Id.* at 214-19.

[132] *Id.* at 217. Concern was expressed that the use of rebuttable presumptions might facilitate unduly the recovery of judgments in a Tier Two action and create more evidentiary barriers for a litigant than these presumptions would resolve. *Id.* at 218; *see infra* note 151 and accompanying text.

[133] REPORT, *supra* note 9, at 214. For a general discussion of the various legal aspects, constitutional limitations, and analogous use of presumptions, see *id.* at 220-33, app. M, at 1-22.

[134] *Id.* at 234. The Recommendation proposed that the claimant should be entitled to additional compensation for injury discovered after the Tier One proceeding. *Id.* at 234-35.

[135] REPORT, *supra* note 9, at 234. A minority of members of the Group had recommended that other collateral sources, such as private insurance proceeds, also be deducted. *Id.* at 238. *See generally* Fleming, *The Collateral Source Rule and Loss Allocation in Tort Law*, 54 CAL. L. REV. 1478 (1966); Note, *Unreason in the Law of Damages: The Collateral Source Rule*, 77 HARV. L. REV. 741 (1964); Comment, *The Collateral Source Rule: Double Recovery and Indifference to Societal Interests in the Law of Tort Remedies*, 2 U. PUGET SOUND L. REV. 197 (1978).

[136] REPORT, *supra* note 9, at 234. Death benefits would be awarded to dependents in an amount related to the decedent's regular earnings and normal life expectancy and the degree of dependency of claimants. *Id.*

[137] *Id.* at 235.

The Sixth Recommendation characterized the program as a grant-in-aid scheme. States which assume the administration of the program would thus be entitled to contribution to the cost of its administration from federal grants.[138] The states would use their own compensation machinery, subject to federal review, to see that the objectives of the program are achieved.[139] After payment of the compensation claim, the state agency would be subrogated to the rights of the claimant. States would then be in a position to assert the claim against the owner, lessee, or user of the disposal site, or against any other party responsible for causing the condition that resulted in the exposure.[140] Foreseeing problems of retroactivity, the Group recommended that subrogation claims only be asserted prospectively. Older claims, therefore, would be paid out of the fund without subrogation.[141]

The Seventh Recommendation provides for the creation of a fund from industry contribution to finance Tier One compensation awards. This fund would be analogous to CERCLA's Superfund, subsidized by federal contributions or taxes, and replenished to some extent through the collection of subrogation claims.[142]

Finally, the judicial review of compensation awards is contained in the Eighth Recommendation. The Study Group recommended that the adequacy and grant or denial of a compensation award be subject to judicial review by the appropriate state court.[143] In addition, a claimant would be entitled to appeal the state court's interpretation of the forthcoming federal guidelines. A reversal of the state court by the federal supervisory agency would be subject to review in the federal court of appeals for the circuit in which the state is located.[144]

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[138] The suggested contribution is as follows: 80% federal, including legal expenses, and 20% state. *Id.* at 234.

[139] *Id.* at 240. It was suggested that federal supervision could be patterned after the NPDES program of the Clean Water Act, 33 U.S.C. § 1342 (1976 & Supp. V 1981), or the permit program of RCRA, 42 U.S.C. § 6925 (1976 & Supp. IV 1980). *See generally* Report, *supra* note 9, at 240-43. Federal powers would be limited, thus leaving much discretion to the state. *Id.* at 241.

State agencies such as workers' compensation boards or environmental control agencies may be utilized to implement the program as long as the goal of nationwide uniformity is maintained. *Id.* at 242.

[140] Report, *supra* note 9, at 241.

[141] *Id.* at 241-45. For a discussion of the constitutional issues raised by retroactivity, see *id.* app. L, at 285-305.

[142] *Id.* at 245-46. Similar to CERCLA, the fund should be established by contributions from, or taxes on, the production of hazardous or toxic chemicals and crude oil, and by a tax on the deposit of hazardous wastes. Further study is recommended to establish whether the class of industries taxed under CERCLA should be expanded. *Id.* at 245. In addition, Congress should consider increasing the tax on industries or seeking contributions from general revenues should the fund become depleted. *Id.* at 247.

The Ninth and Tenth Recommendations discuss the Tier Two proposal, suggesting necessary revisions to common-law and statutory remedies for hazardous waste exposure. Similar to Tier One, the Ninth Recommendation urges the unified adoption of a discovery rule, i.e., that the cause of action accrues from the time the plaintiff discovers or should have discovered the injury and its cause.[145] The Study Group also recommended the adoption of liberal joinder rules so as to allow complex issues of causation and liability to be tried together, leaving such issues as individual damages to separate trial if necessary.[146]

Substantive and procedural rules should be revised to shift the burden of damage apportionment to the defendants proven to have contributed to the risk or injury.[147] Additionally, revision should include the adoption of a rule of joint and several liability.[148] Moreover, laws relating to a landowner's obligations for the maintenance of hazardous waste condition and the issue of a subsequent owner's responsibility should be clarified.[149] Finally, the Ninth Recommendation proposes that the several states apply a theory of strict liability which would focus on the nature of the hazardous waste activity and the magnitude of the risk of injury.[150] The Report, however, rejects extensive use of Tier One rebuttable presumptions[151] and class suits in a Tier Two personal injury claim.[152]

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[143] *Id.* at 252. State courts would review the compensation award according to the provisions prescribed in § 706 of the Administrative Procedure Act, 5 U.S.C. § 706(2)(A) (1976).

[144] REPORT, *supra* note 9, at 252. In the interest of national uniformity, questions relating to interpretation of the federal guidelines are appropriately subject to federal review. *Id.* at 253-54.

[145] *Id.* at 256. The Recommendation is intended to cover the repeal of the statutes of repose which have the same effect as statutes of limitations in barring claims. *Id.*

[146] *Id.* at 256-57; *see supra* notes 56-60 and accompanying text.

[147] REPORT, *supra* note 9, at 258. The Study Group expressed the view that an expanded approach to the "concert of action" theory of apportionment would be the most appropriate approach in a hazardous waste case. *Id.* at 262; *see supra* note 55. In addition to adopting a theory of apportionment, alternative approaches such as "channelling" responsibility to a designated party should be examined by the several states. *See* Price-Anderson Act, 42 U.S.C. § 2210 (1976 & Supp. IV 1980).

Concern was expressed over the impact on the insurance industry which would be generated by the imposition of strict liability on numerous firms or by channelling apportionment to a single, hazardous waste handler. The Study Group obtained the opinion of eight insurance specialists regarding the feasibility of insuring liabilities under these proposals. REPORT, *supra* note 9, at 173-87. Comments from the specialists were generally positive and there were no assertions that the industry could not or would not insure the liabilities. *Id.* at 174. The specialists did express concern with unlimited access to Tier Two because of the potential prohibitory expenses and concluded that a system calling for binding election between the two remedies would be more readily insurable. *Id. See generally* Schmalz, "Superfunds" and "Tort Law Reform"—Are They Insurable (report to § 301(e) Study Group) (copy in the file of the Columbia University Legislative Drafting Research Fund).

[148] REPORT, *supra* note 9, at 258. The Report recommends that any revision of apportionment retain a *de minimus* exception—a "one drum defense"—to provide the necessary element of fairness to joint and several liability. *Id.*

The Tenth Recommendation addresses the problems peculiar to actions for environmental and private property damage. The Study Group found that property-related actions, involving less complex medical and scientific issues, do not require the rapid resolution necessary for issues relating to personal injury.[153] Therefore, the Group recommended that environmental and property damage claims be subject to state review under state law.[154] Nevertheless, recognizing the farreaching environmental impact of hazardous waste, the Group recommended that states adopt the appropriate procedural and substantive changes suggested in the Ninth Recommendation. In addition, the Group suggests that class actions may be more suitable to private property damage claims.[155] The Tenth Recommendation further suggests that states develop remedial actions to provide relief for property damage which is not effectively recoverable in individual suits. Individual suits do not effectively provide relief for certain property damage.[156] Consequently, states must develop remedial programs[157] and assert claims against the Superfund[158] to compensate adequately private landowners for their property loss. The Study Group concluded its recommendations by urging the Federal Government to intensify its commitment to the Superfund and clarify its intent to make monies available to states undertaking the cleanup of hazardous waste sites.[159]

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[149] *Id.* at 259. The Recommendation does not suggest that an owner without knowledge of or consent to the condition be subject to liability. *Id.*

[150] *Id.* at 260; *see supra* notes 101-09 and accompanying text.

[151] The Study Group indicated that the application of rebuttable presumptions in a court proceeding concerning hazardous waste injury should be left to the development of the several states. It was noted, however, that state courts might consider the proposed "Toxic Substance Documents," see *supra* notes 131 & 132 and accompanying text, as valid evidentiary authority in a personal injury suit. REPORT, *supra* note 9, at 265.

[152] *Id.* at 261; *see supra* note 59.

[153] REPORT, *supra* note 9, at 268-69.

[154] *Id.* at 267.

[155] *Id.*

[156] *Id.* at 269; *see supra* note 89.

[157] For instance, the construction of water supply systems to replace contaminated well water would be a more efficient remedy than compensating individual landowners in private suits. *See* REPORT, *supra* note 9, at 268.

[158] The Report suggests two means of asserting claims against Superfund. Section 111 (b) and (c) of CERCLA provide reimbursement to the states for the costs of replacing destroyed natural resources and such public environmental assets as the waters and subsurface waters of the state. 42 U.S.C. § 9611(b), (c) (Supp. IV 1980). In the alternative, states could seek replacement of

V. The Response to the § 301(e) Study Group Report

Unlike many committee study reports which die aborning, the § 301(e) Study Group Report has clearly contributed to the congressional awareness of the hazardous waste problem. Two recent bills introduced evidence this awareness, as well as demonstrate congressional appreciation of the factual and legal complexities surrounding the problem.[160]

The first bill, the Environmental Poisoning Compensation Act, was introduced by Senator George Mitchell (D-Maine) on July 15, 1981,[161] and again introduced on September 30, 1982,[162] by Senator Robert Stafford (R-Vermont) as an amendment to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).[163] The Mitchell/Stafford bill would amend the Superfund law to cover personal injuries from any release of a hazardous substance.[164] Although the Report was recognized as a "benchmark in developing legislation to help thousands . . . exposed to poisonous toxic chemicals,"[165] the bill rejected the Tier One compensation plan. In addition to relying on existing common-law remedies, victims would also have a federal cause of action against a responsible party.[166] This would extend the cause of action currently provided under section 111(b) of CER-

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destroyed natural resources, such as contaminated private water supplies, by filing a claim under § 107 of CERCLA, 42 U.S.C. § 9607 (Supp. IV 1980), on behalf of its citizens, in a representative capacity as *parens patriae*. Report, *supra* note 9, at 269-70.

[159] Report, *supra* note 9, at 270-71.

[160] *See* H.R. 7300, 97th Cong., 2d Sess., 128 Cong. Rec. H 8490 (daily ed. Oct. 1, 1982) [hereinafter H.R. 7300]; S. 1486, 97th Cong., 1st Sess., 127 Cong. Rec. S 7694 (daily ed. July 15, 1981) [hereinafter S. 1486]; *see also Compensation for Exposure to Hazardous Substances: Hearing Before Subcomm. on Investigations and Oversight of the House Comm. on Science and Technology*, 97th Cong., 2d Sess. 133 (1982) (statement of Frank Grad on the Superfund § 301(e) Study Group).

[161] S. 1486, *supra* note 160, at 1.

[162] H.R. 5203, 97th Cong., 2d Sess., 128 Cong. Rec. S 12948 (daily ed. Sept. 30, 1982). Senator Stafford now chairs the Senate Committee on Environment and Public Work, the committee to which this bill was referred.

[163] 7 U.S.C. §§ 136-136y (1976 & Supp. V 1981).

[164] S. 1486, *supra* note 160, at 1.

[165] 128 Cong. Rec. S 12947 (daily ed. Sept. 30, 1982) (statement by Chairman Stafford).

[166] S. 1486, *supra* note 160, § 2(b), at 2.

CLA[167] to pursue those who damage federal or state natural resources.[168] The Mitchell/Stafford legislation would thus continue to use the existing legal standards of causation, in which a claimant must demonstrate the relationship between the exposure and the disease by the weight of credible evidence.

Although the Mitchell/Stafford bill would limit recovery for personal injury to existing legal remedies, it does propose a financing scheme similar to that contained in the Report. Compensation would be available for any out-of-pocket medical expenses, including diagnostic services, rehabilitation costs and burial costs from a fund to be financed primarily from an industry tax on feedstocks and oil and secondarily from direct federal appropriations.[169]

The second piece of proposed legislation, which closely reflects the Study Group Recommendation, goes much further than simply amending existing Superfund legislation to provide for a personal injury claim. This bill, introduced in the House on October 1, 1982 by John J. LaFalce (D-New York), would create a comprehensive, administrative compensation mechanism for hazardous waste exposure claims.[170]

The proposed Toxic Victims Compensation Act would establish a Compensation Board which would certify persons as victims of a hazardous substance release and then award compensation.[171] The bill requires the Environmental Protection Agency (EPA) to develop "hazardous substances release studies," to state whether it reasonably believes that a release has occurred and has created a potential for injury or damage, and to estimate the probable extent of injury or damage.[172] Similar to the Report's proposed Toxic Substance Documents,[173] the EPA studies would constitute "conclusive evidence" to support claims, and would thereby create a rebuttable presumption in favor of the claimant.[174] The EPA would be subrogated to the rights of the claimants, allowing it to seek reimbursement from the responsible parties.[175] Claimants would be subject to a three year statute of limitations, which would run from the date the injury or damage was or reasonably should have been known to exist.[176]

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[167] 42 U.S.C. § 9611(b) (Supp. IV 1980).

[168] S. 1486, *supra* note 160, at 3; *see* 128 Cong. Rec. S 12948 (daily ed. Sept. 30, 1982).

[169] S. 1486, *supra* note 160, at 3. The Mitchell proposal would provide a fund of $3 billion over 10 years. *Id.* Similarly, the Stafford bill proposed a $5 billion fund over a 10 year period. 128 Cong. Rec. S 12948 (daily ed. Sept. 30, 1982). Under both versions, however, 88% of the funds would come from an industry tax and the remainder would be federally financed.

[170] H.R. 7300, *supra* note 160, at 2-3. Representative LaFalce currently represents the Love Canal area. The bill, providing for "liability and compensation for personal injury, illness, and economic loss resulting from releases of hazardous substances into the environment," 128 Cong. Rec. H 8507 (daily ed. Oct. 1, 1982), was referred jointly to the House Committees on the Judiciary, Education and Labor, and Energy and Commerce. *Id.*

[171] H.R. 7300, *supra* note 160, at 19-22.

[172] *Id.* at 14-16.

[173] *See supra* notes 131 & 132 and accompanying text.

[174] H.R. 7300, *supra* note 160, at 14-16.

As in the Study Group proposal, the administrative remedy would not be exclusive. Compensation under the administrative scheme would be substantially the same as proposed by the Study Group, except that compensation for lost wages would be limited to 80% of the actual loss or 80% of the statewide average wage, whichever is less.[177] If the claimant chooses to file suit in court as well, damages for pain and suffering, relocation, and property damage would be available.[178] Moreover, duplicative awards for personal injury would have to be reimbursed to the fund.[179]

The response from Congress indicates the acknowledgment of a problem to which no easy answers are available. Proposed legislation recognizes the manifold issues facing the public, the industry, and the judiciary. There is yet another and more serious problem which the Study Group and the Report do not address. It is one thing to examine the effects of hazardous waste and to propose improvements in existing legal rights and remedies. It is something else again to address the problem of the *causes* of these injuries and damages, in contradistinction to aiding victims because of the *effects*. As one of the members of the Study Group has stated:

> The significant lesson learned from this (the Group's work) is that future emphasis—economic, legislative, legal—should focus on avoiding toxic injury problems. . . . Today and tomorrow's efforts and legislation should concentrate on having generators of hazardous waste develop ways to make them benign. Emphasis should be on the treatment of waste materials to make them safe. . . . It is not farsighted to justify current industrial activity on the grounds that economic pressures at home or from abroad mandate that we permit today what we can anticipate will be a greater problem tomorrow. . . . It would be nice if one could anticipate that free-market economic forces, left unfettered, would lead to the goals we seek. That has not happened. It is unlikely to happen when short-term gain conflicts with long-term problems and costs.

> It is difficult to ask that we act now to protect future generations. It is, however, both wiser and kinder to do this than for us to ask those yet unborn to pay for what we enjoy. . . .
>
> Unless we live within the capabilities of our resources and knowledge, we are putting at risk the futures of others. One of the sound tenets of our economic system has been that one saves now to invest for the future, for oneself and others. Unless we adopt this prudence in our approach to toxic injury and damage, we run the risk of bankrupting the lives and futures of others.[180]

With those observations we agree but further discussion is for another time, another place. Whether or not government ever will meet the larger question of cause, we must now address and redress effects. As stated recently:

> Government is deeply into the business of damage control. It devises and administers programs to tend the casualties of business cycles, assembly line conditions, industrial pollution, and urban decay or city blights. By definition, welfare and health programs do not reform the basic structure of power, production, or ownership: they treat its victims.[181]

Individual victims cannot be ignored today in the hope that government may decide to protect the common weal tomorrow.

This Report is not to be viewed as the final word on the subject. Problems of regulating hazardous substances and hazardous waste are likely to be with us for a long time. Legal and technical solutions, too, will take time to develop, to take account of the experience gathered in their initial application. Law reform and the development of sound legislation has always been a continuing development. We view the Study Group Report as a significant step in an incremental process.

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[180] Report, *supra* note 9, at 350-52 (final comments by Weyman I. Lundquist).

[181] Editorial, Democracy, Spring 1983, at 4.

EXCERPT FROM THE TESTIMONY OF WEYMAN I. LUNDQUIST BEFORE THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT OF THE HOUSE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION, JULY 26, 1983.

THE DIVERSITY OF THE 301(e) STUDY GROUP MEMBERSHIP

For any group to speak with authority concerning legislation, it should be a group representing a spectrum of views and having no particular bias. Ideally, this constituency should include the views of academicians, the government, lawyers who represent individuals, lawyers who represent commercial interests, and appropriate associations. The Study Group was made up of such a membership. Study Group members were appointed by four separate organizations. They were the American Law Institute, the American Bar Association, the American Trial Lawyers Association, and the National Association Of Attorneys General.

It is clear from the composition of the Study Group that Congress did not intend and did not create a group that would reach an easy consensus. The variety of interests that were reflected in the Study Group, however, did not lead to an inconclusive report. The final report reflects substantial agreement by the Study Group members. Although some of the Study Group members submitted separate comments to the report, these comments generally did not dissent from the basic two-tiered remedial proposal. Even the dissenting comments, those of Judge Breitel and those of George Freeman, supported the establishment of an administrative compensation remedy while allowing claimants an opportunity to pursue common law remedies.

It should be noted that some of the committee members - both plaintiffs' lawyers and defense lawyers -- have a vested self-interest in their espoused views. As the discussions of the Group progressed, it became evident that certain other Group members, particularly academicians, sometimes also had a vested interest in views they had expressed over a number of years. Not surprisingly, each constituent group of this committee was conservative in favoring what it knew best. This was as true of the plaintiffs' lawyers as it was of the defense oriented counsel.

THE GROUP'S DELIBERATIONS

The Study Group had no doubt that toxics are a problem. They are a problem because there is some individual harm. They are a problem because of public concern about potential harm. They are a problem because of the latent harm that they may yet create. As they continue to be developed, toxics present an increasing problem in American society. Among the more difficult dilemmas the Group faced, however, was evaluating how immediate the problems are and what solutions might be most expeditious and economic. The Group was also confronted with questions involving bars to recovery and the transactional costs of resolving these problems.

A major conundrum underlay the Group's deliberations: what is the size of the problem? We know without question that large numbers of people have been exposed to toxic risks. The extent of physical detriment suffered by these people is less well known and less well established. Developing medical science increasingly enables us to learn why people become diseased and die. A few short decades ago such determinations would not have been possible. Some who develop diseases may be significantly disabled by them, and in the main more people continue to live longer. Thus, the actual harms caused by toxics are difficult to measure.

Because of the multifactorial etiology of most of the injuries that are related to exposure to toxics, most of the scientific literature is very inconclusive as to injury causation. Disease incidence in populations that have been exposed to a given toxic substance is usually reported either simply as incidence, without any conclusion as to causation, or at best as a correlation. Some of the paucity of the causation conclusions is related to the high burden of proving statistical significance in scientific stuidies. Some is related to the dose-response curve; researchers who are willing to make causal conclusions regarding high exposure levels may be unwilling to make the same conclusions regarding lower exposure levels -- exposure levels that may still be toxic, but for which the incidence of injury is so low that the data necessary to prove causation are not available. Furthermore, for a great number of scientific conclusions regarding toxic substances, whether the conclusions have been in the form of correlations or causal connections, further studies have either failed to replicate the original results or have reached contradictory results. In addition, the synergistic effect of toxics with other harmful substances -- particularly smoking -- makes it difficult to give definitive answers.

Even for those substances where a causal relationship between the toxic substance and an injury is accepted, there is almost a complete absence of data that indicates the age groups affected, which in turn would indicate how many lives are actually being shortened or severely impaired by the injuries that result from exposure to these toxic substances. Both the Love Canal data and the asbestos data suggest that most injuries manifest themselves in older populations. However, substances such as DES and DBCP have been proven conclusively to have severe effects early enough in the lives of the victims so as to seriously disrupt their lives, lifestyles and life expectancies.

Since the Supreme Court's Benzene[6] decision, administrative agencies have not been able to regulate exposure to toxic substances unless there is sufficient data to prove that there is a "siginificant" risk of harm from these substances. Thus various substances that may be toxic cannot be regulated at the present time because of insufficient scientific evidence of harm, or because of insufficient scientific data regarding the toxicity of these substances at low exposure levels. Because of the long latency period between exposure to toxics and the resultant injuries, it is thus possible, and in fact likely, that mass toxic tort injuries caused by these substances will manifest themselves in the future. As Judge Breitel noted in his separate comment to the Study Group report, "[t]here are toxic substances and wastes which were, on any test, deemed not harmful and even beneficial at one time. And there are substances today, without any determinable responsibility, which appear to be utterly harmless or even beneficial or essential, which later, or tomorrow, will have been discovered to be toxic singly or in synergistic relation with other substances."[7] Indeed, the lack of scientific conclusions as to causation does not indicate that various substances are not toxic or will not cause toxic harms. Rather, the absence of data merely indicates that researchers have not yet been able to prove that particular substances are not safe. The Study Group was thus confronted with the situation where the extent of these harms has not yet been quantified.

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[6] Industrial Union Dep't, AFL-CIO v. American Petroleum Inst., 448 U.S. 607, 653 (1980) (plurality opinion).

Furthermore, a few short decades ago, people's life spans were substantially shorter. Indeed, one of the ironies of what we face is that the lives of many people will ultimately be adversely affected by toxics and yet their life expectancies have been increased by the very societal developments that were made possible by these substances. Asbestos and pesticides are good examples of this. Thus, we are seeing people who ultimately die or are disabled by exposure to the very substances that have permitted the lifestyle that has extended their lives.

With this background of factual uncertainty, the Study Group focused on some of the problems that confront an injured plaintiff who attempts to seek compensation for a toxic injury. The most significant of these problems are the statute of limitations, joinder of parties, and proof of causation. Because of the long latency period before the manifestation of injury that results from exposure to toxic substances the statute of limitations presents almost a complete bar to recovery in those states that have not accepted a discovery rule. Plaintiffs may lose their right to bring a lawsuit before they have learned of their injuries. Ownership of a hazardous waste site, or of a corporation that produces a toxic substance, may have changed during the long latancy period. The questions of liability and apportionment of liability thus become complex. Because of the complexities inherent in toxic tort suits, the costs of pursuing an action become a substantial barrier to a plaintiff's recovery unless joinder of plaintiffs or class action is available. Because of the multifactorial etiology of the injuries most commonly associated with toxic substances -- cancer and lung disease -- proof of causation is extremely difficult. Medical and scientific testimony, used to establish causation, is prohibitively expensive, even in cases in which the etiology of a disease may be rather clear. In the face of such problems, many of the committee members were of the view that the costs of disposing of toxic harm claims were excessive and, indeed, that the victims of toxic harms are frequently compensated less than those who act on their behalf -- their lawyers.

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[7] 1 Report, supra note 4, at 297 (Comments by Charles D. Breitel).

Further, there is currently no federal statute that expressly provides a remedy for personal injury due to hazardous waste exposure in non-occupational settings and state statutes creating such remedies are rare. Plaintiffs in most situations must rely on common law tort causes of action.

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COMPROMISES INCORPORATED IN THE RECOMMENDATIONS

The diversity of the 301(e) Study Group membership necessitated that various interests would have to be reconciled to achieve a compromise recommendation. The Plaintiff's Bar, with its contingent fee interests and its concern for preserving the right to jury trials, was reluctant to endorse any recommendation that would have included a binding election between administrative and tort remedies. The academicians in the Group were more inclined to take a systemic view of the problem, and to be concerned about the forum-clogging, burden on judicial resources, and excessive disposition costs that extended judicial procedures might create. They were thus concerned about the duplication allowed by a scheme

General, having a more practical orientation, were more willing to compromise so as to reach a consensus recommendation. In my view, because in current dollar terms the average damage claim for hazardous waste injury is likely to be in the $10,000 to $15,000 range, I am inclined to believe that our Tier One-Tier Two Recommendation is practical; most claims will be handled by the administrative remedy and will not necessitate a tort action in court.

As noted in their separate statements that follow the Study Group Report, a number of the study group members felt that an alternative to the recommended relationship between Tier One and Tier Two remedies would be more advantageous. Under this scheme, an election to obtain the administrative award would be binding, and a plaintiff would need discretionary judicial approval to bring a Tier Two (tort) action. A plaintiff would only be allowed to pursue a tort remedy in the event of an unanticipated cause of action for damages available under tort law beyond that recoverable at the administrative level. Those Study Group members who prefer this binding election between remedies, rather than the exit toll created by the Study Group's recommendations, do so because they find the availability of combined Tier One and Tier Two remedies to be unnecessarily duplicative, inefficacious, and inequitable. Judge Breitel in particular has expressed the view that "[t]he 'exit toll' is not severe enough to avoid 'gambling', that is, obtaining easy recoveries at the administrative level, and then pursuing the plenary action."[9] In my view, if the majority of claims are not large, then they are not likely to be pursued in court -- "the game is not worth the candle." It may be that some restrictions will have to be placed on lawyers amassing numbers of claims to prevent undue economic motivation for lawyers, if not their clients.

Another area of compromise concerned the definitions of causation, presumptions, and discovery of injury. Mr. Freeman in particular, as I am sure he will testify to at length before this Subcommittee, was critical of the statutory presumptions proposed by the Study Group. Both Mr. Freeman and Judge Breitel objected to the use of legislative fiats that reflect policy biases as a substitute for the truth in an area in which the truth is elusive.[10]

Judge Breitel and Mr. Freeman were both particularly concerned that an insufficient cost-benefit analysis had been performed.[11] Both question whether subrogation of claims and taxing of various selected industries are the most appropriate ways to fund such an administrative compensation scheme.[12] Mr. O'Connell was concerned both that the availability of Tier One, subrogation, and Tier Two proceedings would place an undue burden on the judicial system,[13] and that the availability of compensation from a Superfund-type trust fund, in addition to payments available under private health insurance, sick leave and disability insurance, would result in a windfall to claimants.[14] A number of the Study Group members were also disconcerted that the Study Group's recommendations did not include awards for psychological, social, and related injuries in the Tier One administrative remedy.

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[9] 1 Report, supra note 4, at 299 (Comments by Charles D. Breitel).

[10] Id. at 299-300 (Comments by Charles D. Breitel), 314-19 (Comments of George Clemon Freeman, Jr.).

[11] Id. at 301 (Comments by Charles D. Breitel), 314 (Comments of George Clemon Freeman, Jr.).

[12] Id. at 301-02 (Comments of Charles D. Breitel), 311-14 (Comments of George Clemon Freeman, Jr.).

As I stated in my final comments to the Study Group Report,[15] I endorse the Report. I am also comfortable with the Anderson, Breitel, Freeman, O'Connell position (binding election between Tier One and Tier Two with judicial discretion to allow tort actions after an administrative remedy has been elected),[16] and could join this position should Congress deem it advisable.

EXCERPT FROM THE STATEMENT OF GEORGE CLEMON FREEMAN, JR. OF THE LAW FIRM OF HUNTON AND WILLIAMS, RICHMOND, VIRGINIA BEFORE THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT OF THE HOUSE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION, JULY 26, 1983.

For proper perspective on policy alternatives, you need to read these individual views as well as Professor Grad's report for the majority.

Since Weyman Lundquist, another member of our Superfund Study Group, who is scheduled to precede me today, will summarize the Report's recommendations, I will not repeat what he will say. It might be more helpful if I summarized my perception of the positive contributions made by the Report to the overall policy debate and then expressed my reasons for concurring in some but not all of the Report's recommendations. In the area of positive contribution:

1. The Report recognizes that data as to the scope of the problem are not now available -- therefore the problem may be one of perception instead of actuality.[3]

2. The Report correctly interprets the City of Milwaukee and Sea Clammers cases to conclude that no federal "common law" of tort or nuisance exists in this area but that state common law is alive and well.[4]

(footnote continued)

to the Appendices" at the rear of Part 2 of the Report, but which were inadvertently omitted from the Part 2 Table of Contents.

[3] The Superfund Study Group had much the same experience as this Subcommittee originally had in not being able to obtain much information on Superfund related matters from EPA. *See e.g.*, Superfund § 301(e) Report, Part 1, pp. 21-39, 310-311; Part 2, Letters of Dec. 16, 1981, and Mar. 2, 1981, in the Comments to the Appendices. All references to page numbers are to those at the top of pages in the Congressionally printed Report.

[4] *See* Superfund § 301(e) Report, Part 1, pp. 87, 323-324; Part 2, pp. 151-152, letters of Dec. 16, 1981; Apr. 29, 1982; May 17, 1982, in the Comments to the Appendices.

3. The Report unanimously recommends against creation of a Federal statutory judicial tort or nuisance (Tier Two) remedy.[5]

4. The Report recognized the problems associated with the Black Lung Act and rejected it as a model for recommendations in this area.[6]

5. The Report rejected endorsement of the Enterprise and Market Share Liability Theories.[7]

6. The Report, in recommending creation of a Tier One (administrative compensation system), rejected the notion of retroactivity in subrogation of Tier One claims.[8]

7. The Report recommends that injuries covered by Workmen's Compensation be exempt from any Tier One system.[9]

8. The Report recognizes that the statutory presumptions proposed for the Tier One administrative system would be inappropriate in the Tier Two judicial system.[10]

9. Finally, the addition of Section III B of Report on insurance law and thought-provoking criticism of current joint and several liability rules were major contributions to thoughtful consideration of tort law reform generally.[11] In particular the recommendation of consideration of the substitution of "channelling" for "joint and several

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[5] See Superfund § 301(e) Report, Part 1, pp. 290-291, 307.

[6] See Superfund § 301(e) Report, Part 1, pp. 195, 178, 228.

[7] See Superfund § 301(e) Report, Part 1, p. 262.

[8] See Superfund § 301(e) Report, Part 1, pp. 176, 245-246.

[9] See Superfund § 301(e) Report, Part 1, p. 207.

[10] See Superfund § 301(e) Report, Part 1, p. 60.

[11] See Superfund § 301(e) Report, Part 1, pp. 162-192.

> liability" in both Tiers One and Two merits far more attention than it has so far received.12/ The adoption of "channelling" would result in swifter, full compensation with lower transaction costs and the elimination of duplicative insurance. The net result would be better for persons injured or damaged and for the public, which bears the ultimate costs of the system through the costs of goods and services.

Turning to the Report's recommendations, I concur in the recommendation for creation of a Tier One administrative compensation system for the reasons set forth in my separate statement at pages 308 to 310 of the Printed Report.13/ But there are five areas where I have problems with the recommendations and the Report:

1. I did not think we knew enough to make a recommendation to Congress on the source of the Tier One funds. For that reason, I did not concur in the recommendation to fund it through an add-on to the existing Superfund taxes.14/
2. I strongly concurred with Judge Breitel's dissent from the recommended statutory presumptions in Tier One.15/

12/ *See* Superfund § 301(e) Report, Part 1, pp. 181-183, 258, 324.

13/ For the convenience of the Committee, a reprint of my separate statement in the Superfund Report is reproduced as Attachment A to this testimony.

14/ *See* Superfund § 301(e) Report, Part 1, p. 245; *but see*, Freeman's Statement. Part 1, pp. 311-314.

15/ *See* Superfund § 301(e) Report, Part 1, pp. 213-219; *but see* Breitel's and Freeman's statements, Part 1, pp. 299-300, 314-318.

3. I joined Judge Breitel and Professors Anderson and O'Connell in deploring the failure to recommend the requirement of a limited binding election between the Tier One administrative remedy and the Tier Two adjudicatory remedy.16/

4. I thought Judge Breitel's criticism of the Report's overbroad description of "Strict Liability" was right on the mark.17/

5. I deplored the failure of our Group to address the punitive damages issue in the Report, despite our consideration of that issue in our meetings.18/

There are a number of bills pending in both Houses that deal with some of the issues we addressed in the Superfund § 301(e) Report. Unfortunately, some of the more interesting of the Study Group's suggestions such as consideration of the substitution of "channeling" for "joint and several" liability as the means for apportioning liability,19/ have not yet made their way into the political debate. Some of the Congressional

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16/ See Superfund § 301(e) Report, Part 1, pp. 197-205; but see, Joint Statement of Anderson, Breitel, Freeman and O'Connell. Part 1, pp. 286-288.

17/ See Superfund § 301(e) Report, Part 1, pp. 122-123, 265-266; but see, Breitel's Statement. Part 1, pp. 298-299; Freeman's letter on this in the Comments to Appendices. Part 2, Letter of Mar. 10, 1982.

18/ See, Freeman's Statement, Superfund § 301(e) Report, Part 1, pp. 322-323.

19/ See Superfund § 301(e) Report, Part 1, pp. 177-184, 258, 262-263; Schmalz, Superfund and Tort Law Reforms: Are They Insurable? 38 Bus.Law. 175 (1982) (Attachment D to this statement).

"Superfund" proposals, even those in the Senate which supposedly are intended to "implement" the Study Group's recommendations, contain provisions we considered and rejected.

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C. Generator ("Vicarious, Strict") Liability

Another issue where Congress was deliberately equivocal concerning the Superfund Act involves the standard of care to which defendants are to be held under the statute. Specific references to "strict liability" were deleted, and instead the Act defines the Act's standard of liability to be the same as that under § 311 of the Federal Water Pollution Control Act.50/ While it is clear that this standard is one form of strict liability for the owner or operator of a vessel from which there is a hazardous release, it is much less certain what the reference means in other contexts such as the liability of hazardous waste generators arising out of disposal of wastes by others at sites off of the generator's property.

50/ 42 U.S.C. § 9601(32).

Superfund appears to impose liability for cleanup costs on generators, transporters and owners and operators of waste facilities. However, there are now some indications that courts will not impose liability on those who do not contribute substantially to (are not a legal cause of) the problem requiring cleanup.51/ That is, in the absence of negligence, courts may hold that a generator's activity did not proximately cause the damage resulting from an accident at an offsite disposal facility operated by another.52/

The scope of generator liability within the context of federal enforcement of RCRA is also a subject of hot dispute today. A question under RCRA section 7003 has been whether a generator is always a person "who contributes to" an imminent hazard at someone else's disposal site. A post-hoc interpretation of these words appears in a Senate Committee report on the 1980 Amendments to RCRA. The report states:

51/ City of Philadelphia v. Stepan Chemical Co., 544 F.Supp. 1135, 1143 n.10 (E.D.Pa. 1982) (dicta); see State of New Jersey Department of Environmental Protection v. Ventron Corporation, et al., 182 N.J.Super. 210 (App.Div. 1981) (New Jersey spill compensation Act); Rodberg, Apportionment of Damages in Hazardous Waste Litigation, in Mott. ed., Hazardous Waste Litigation 1982 183, 213 (1982); Dore, The Standard of Civil Liability for Hazardous Waste Disposal Activity: Some Quirks of Superfund, 57 Notre Dame Law. 260, 276 (1981).

52/ Cf. United States v. Wade, 546 F.Supp. 785 (E.D.Pa. 1982), appeal pending No. 82-1715 (3d Cir.) (RCRA § 7003 and Superfund § 106 do not apply to past non-negligent off-site generators of wastes).

> For example, a company that generated hazardous waste might be someone "contributing to" an endangerment under section 7003 even when someone else has deposited the waste in an improper disposal site . . . where the generator had knowledge of the illicit disposal or failed to exercise due care in selecting or instructing the entity actually conducting the disposal.53/

Justice Department prosecutors, who have the clearest interest in the broadest possible theory of generator liability under federal statutes, concede that the particular factual setting of an incident is important to deciding whether there should be generator liability.54/ And the Carter Administration's Interagency Task Force on Compensation and Liability for Releases of Hazardous Substances did not consider absolute generator liability to be among its options for liability under the Superfund Act.55/

53/ S.Rep. No. 172, 96th Cong.,2d Sess. 5, reprinted in [1980] U.S. Code Cong. & Ad. News 8605, 8669; cf. U.S. v. Wade, 546 F.Supp. 785, 791 (E.D.Pa. 1982) (the full Senate Committee discarded the strict liability approach).

54/ E.g., see Briefs in pending United States v. Chem-Dyne, Civil Action No. C-1-82-840 (S.D.Ohio) (parties appear to agree that the Superfund Act does not require joint and several liability in all cases); Reply Brief of the United States on Motion for Partial Summary Judgment and Injunctive Relief, United States v. Petro Processors of Louisiana, 2 Chem. & Rad. Waste Rep. 120, 126 (M.D.La. 1981).

55/ See Department of Justice, The Superfund Concept, June 1979, at 74-77.

The generator ("vicarious strict") liability and apportionment of liability ("joint and several") problems are inextricably intertwined, as various commentators have pointed out.

> In the debate some seem to have lost sight of, or at least glossed over, the real significance beyond Congress' omission of joint and several liability. Inclusion of joint and several liability in the statutes would reflect a legislative judgment of public policy akin to what underlies master-servant or partnership vicarious liability. In other words, a generator who is a substantial factor in bringing about some of the injury might constitutionally be held liable for all of the harm caused by the owner/operator of the facility on public policy ground regardless of legal (proximate) causation in the common law sense, or the indivisibility or not of the injury. The absence of such a joint and several liability provision in Superfund means that Congress has not come to grips with any public policy issue.56/

In my view, the single most important issue in the current tide of Superfund litigation today is whether a nonnegligent generator can be held liable for a major share of cleanup costs simply because of evidence demonstrating that his wastes were present when a release occurred or was threatened at a facility handling the wastes of many generators. The potential for grossly disproportionate vicarious liability

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56/ Rodberg, Apportionment of Damages in Hazardous Waste Litigation, Hazardous Waste Lit. 1982, 183, 204-205 (1982).

explains why some companies refused to settle in the recent Chem-Dyne agreement.

> "We didn't put it there and you'll never take us alive," was the reasoning attributed to some companies by an EPA official.57/

D. Retroactivity

Intimately related to generator liability issues in Superfund litigation is an issue that, quite remarkably, has not been raised directly in the first Superfund suits originated by the United States to reach initial judicial opinions: retroactivity. A court in one Superfund action brought by a state did find that Congress intended for the statute to be applied retroactively in general.58/ Retroactive application of a more stringent liability standard can render an unobjectionable legal standard unconscionable.59/ In addition, retroactive application of a vicarious, strict liability raises

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57/ Ward, Settling at Chem-Dyne, 1 Envtl. Forum 7, 15 (Dec. 1982).

58/ Ohio v. Georgeoff, Civil No. C-81-1961 (N.D. Ohio, May 3, 1983). The question of the constitutionality of this retroactivity was reserved for future resolution by the trial judge in this case.

59/ Cheek, Risk-Spreaders or Risk Eliminators? An Insurer's Perspective on the Liability and Financial Responsibility Provisions of RCRA and CERCLA, 2 Va.J.Nat.Resources L. 149, 167 (1982).

serious constitutional due process questions analogous to the explicit prohibition of *ex post facto* laws in the criminal area.60/ Indeed, the concepts of fairness and substantial

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60/ U.S. Const., Art. I, § 9, cl. 3 (Congress forbidden to pass ex post facto laws); U.S. Const., Art. I, § 10, cl. 1 (state legislatures forbidden to pass ex post facto laws); the framers of the Constitution intended the clauses to apply to retroactive civil legislation as well as criminal legislation. *See* Crosskey, *The Ex Post Facto and Contract Clauses in the Federal Convention: A Note on the Editorial Ingenuity of James Madison*, 35 U.Chi.L.Rev. 248 (1968); Field, *Ex Post Facto in the Constitution*, 20 Mich.L.Rev. 315 (1922) but the clauses have been construed to apply *per se* only to criminal statutes. *Calder* v. *Bull*, 3 U.S. (3 Dall.) 386 (1798); the following state constitutional provisions prohibit all retroactive legislation: Colo. Const., Art. II, § 11; Ga. Const., Art. I, § 3(2); Idaho Const., Art. XI, § 12; Mo. Const., Art. I, § 13; N.H. Const., Art. I, § 23; Ohio Const., Art. II, § 28; Tenn. Const., Art. I, § 20; Tex. Const., Art. § 16; *cf*. *Murrill* v. *State Board of Accountancy*, 97 Col.App.2d 709, 218 P.2d 569 (1950) (retroactivity violated due process clause); *Gayle* v. *Edwards*, 261 Ala. 84, 72 So.2d 848 (1954) (state constitutional violation found in failure to disclose in title of legislation its retroactive effect); Sutherland, Statutory Construction, §§ 41.02 - 42.12; *Lundquist* v. *Coddington Bros., Inc.*, 202 F.Supp. 12 (W.D. Wis. 1962) (statute may not apply retroactively to revive a cause of action already barred by the statute of limitations); *Haase* v. *Sawieki*, 20 Wis.2d 308, 121 N.W.2d 876 (1963) (statute attempting to reinstate cause of action objectionable); *Massey* v. *Sullivan County*, 464 S.W.2d 548 (Tenn. 1971) (statute abolishing rule of no contribution for joint tortfeasors cannot be applied retroactively). A law will not be construed as retroactive unless the act clearly, by express language or necessary implication, indicates that the legislature intended a retroactive application. *United States* v. *Whyel*, 28 F.2d 30 (3d Cr. 1928); *Crawford* v. *Worth*, 447 F.2d 738 (5th Cir. 1971); *First Nat. Bank in Billings* v. *First Bank Stock Corp*., 197 F.Supp. 417 (D.Mont. 1961); *Elliot* v. *Volpe*, 328 F.Supp. 831 (D.Mass. 1971); *Douglas Aircraft Co*. v. *Cranston*, 58 Cal.2d 462, 24 Cal.Rptr. 851, 374 P.2d 819 (1962) ("a statute should be given the least retroactive effect that its language reasonably permits."); *Mau* v. *Superior Court*, etc., 101 Cal.App.3d 875, 881; 161 Cal.Rptr. 895, 898 (1980)

(footnote continued)

justice which underlie these constitutional concepts also serve as the philosophical underpinning for the general rule of construction that a statute is to be given only prospective application.61/ When a New Jersey appellate court was presented with the argument that the liability standard for cleanup costs under the New Jersey Spill Control and Compensation Act62/ was unconstitutional as retroactively applied, the court held that there was no problem because the statute did *not* actually impose a new "substantive liability." Instead, it held that this state precursor of the national Superfund law "was remedial only, providing a procedure for the imposition of costs to pay for the cleanup of *prior wrongful* discharges."63/ One legal commentator who has thought about these issues in the context of the federal Superfund Act has adopted a somewhat similar solution. He construes the "due care" defense to liability as

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(footnote continued)

(unfairness of retroactive application to insurers who relied on the previous law in setting premium rates).

61/ *See United States* v. *Heth*, 7 U.S. (3 Cranch) 399 (1806).

62/ N.J.S.A. 58: 10-23 *et seq* (1977).

63/ *New Jersey* v. *Ventron*, 182 N.J. Super. 210 (App. Div. 1981) (emphasis added); *cf*. *State Dept. of Env'tl Prot.* v. *Exxon Corp*., 151 N.J. Super. 464, 376 A.2d 1339 (1977) (constitutional difficulties preclude retroactive application of New Jersey Spill Compensation and Control Act).

preventing the "imposition of strict liability" on past off-site generators under the Act.64/ While this same commentator has concluded that Congress generally intended for the liability set forth in the Act to apply retroactively, he admits that the issue is not free of doubt:

> It is easy to argue, of course, that if retroactive effect were intended, Congress could have simply inserted a clause clearly stating that the liability provisions were to apply to pre-enactment waste generators. The noticeable absence of such a clause may create enough ambiguity to require an examination of the Act's legislative history to determine if Congress displayed a clear intent to permit retroactive construction.65/

The Senate Report on S.1480 explained that the justifications for the imposition of strict liability in the Superfund context were to promote fairness and equity, to encourage the exercise of greater care, and to cause "the costs of injuries [to] be borne by the activities which caused them."66/ But none of these underlying purposes is served through retroactive application of such a standard. As many commentators have pointed out, such application would "externalize, rather than

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64/ Note, Generator Liability Under Superfund for Clean-Up of Abandoned Hazardous Waste Dumpsites, 130 U.Pa.L.Rev. 1229, 1263, 1263 n.176 (1982).

65/ *Id.*, at 1241.

66/ S.Rep.No. 96-848, 96th Cong., 2d Sess. 33-34 (1980).

internalize, costs by imposing liability for harm on innocent parties . . . [whose] conduct which, under the laws applicable at the time, was neither unlawful, nor tortious, nor a nuisance . . . ."67/ Professor Kenneth Abraham of the University of Maryland, said recently in explaining the insurance implications of the combination of strict, joint and several, retroactive liability:

> Recent developments in tort law also may hinder accurate insurance pricing. Such doctrinal innovations as shifting burdens of proof as to causation and apportionment of damages, the market share liabilty [sic] concept, and joint and several liability by independent tortfeasors are not merely alterations in the traditional burdens of proof. In practice, the doctrines enable some plaintiffs to recover damages from defendants who have not actually caused the loss (or the entire loss) in question. Minimally culpable defendants, for example, may be held liable for all damages suffered by a victim when, in fact, his injuries resulted from the combined activities of many other actors. Insurance premiums will have to take account of this liability exposure.68/

Finally, the imposition of these doctrines on a retroactive basis could push the cost externalization over that Plimsoll line of "due process."69/

67/ Cheek, supra, at 167-168. And see my letter to Frank Grad of March 10, 1982, which is included in the "Comments to the Appendices" in the back of Part 2 of the Superfund § 301(e) Report.

68/ Abraham, Cost Internalization, Insurance and Toxic Tort Compensation Funds, 2 Va.J.Nat.Resources L. 123, 129-130 (1982).

69/ Fikes v. Alabama, 352 U.S. 191, 199 (1956) (Frankfurter, J., concurring).

Notwithstanding all this, neither the generators nor the amici Chemical Manufacturers Association initially raised the retroactivity issue in the Wade case, which has become a central focus for judicial interpretation of the Superfund Act. As the United States pointed out in its reply brief:

> Nowhere do the Generators or CMA confront the anomaly created by the decision below: the very same generators who are subject to recoupment after EPA undertakes remedial action are not subject to an order under the endangerment provisions to assist in abating the hazards to which their wastes have contributed.70/

But the anomaly cuts both ways. It would also disappear if the court recognized that no new substantive liability was created under the Superfund Act with respect to past acts, i.e., if a due care standard embodying previous common law is the liability standard of section 107 as applied to past acts. And if this is not the correct interpretation, courts will ultimately have to confront the constitutional questions.

If Congress decides to enact new legislation creating a federal administrative remedy or a federal cause of action for persons who have been injured or whose property has been damaged by hazardous wastes, it should scrupulously avoid imposing liability retroactively. As I pointed out earlier, one

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70/ Reply Brief for the Appellant, U.S. v. Wade, No. 82-1715, at 4, Haz.Waste Lit.Rep. 3859 (Apr. 5, 1983).

of the most important decisions in our Superfund Study deliberations was our unanimous recommendation _against_ any form of retroactivity in federal legislation.71/

Statement of
Leslie Cheek, III
Vice President-Federal Affairs
Crum & Forster Insurance Companies
before the
Subcommittee on Investigations & Oversight
of the
Committee on Public Works and Transportation
U.S. House of Representatives
concerning
Compensation of Persons Alleging
Injuries or Diseases Resulting from
Exposure to Hazardous Substances

July 27, 1983

Mr. Chairman and Members of the Subcommittee:

The Crum & Forster Insurance Companies are the Nation's fourteenth-ranked group of property-casualty insurers, with 1982 premiums of approximately $1.7 billion. We appreciate the opportunity to appear before you to discuss proposals to create new mechanisms for the compensation of persons alleging injuries or diseases resulting from exposure to hazardous substances.

As insurers, it is our chosen lot to collect and pool the funds that those subject to a variety of liability regimes will need to meet their legal obligations and that we need to fulfill our contractual obligation to defend our policyholders against third-party claims.

Our companies are among the largest writers of coverage for the principal non-fault system in the United States, workers' compensation, and of coverage for businesses subject to tort and environmental cleanup liability, Comprehensive General Liability (CGL) and Environmental Impairment Liability (EIL). We also write a substantial amount of insurance for vehicle owners in

States with hybrid fault and no-fault systems of auto accident compensation. The lessons we have learned from our experience in servicing these liability and compensation schemes may be useful to the Subcommittee.

Our principal interest in any compensation or liability system is the predictability of its costs. Without reasonable certainty as to how many persons will make claims against the system, and how much on the average each claim will cost, we cannot determine the appropriate premium for the coverage we provide.

The Congress, too, must be sensitive to the predictability of the costs of any system it creates to deal with what we believe is a poorly defined and perhaps nonexistent problem. Congress' last venture into a specialized compensation mechanism, the Black Lung Benefits Act of 1969, was initially estimated to cost less than $40 million per year. Costs under the Act are currently $2 billion per year.

The premise underlying the Superfund §301(e) Study Group's proposals for new mechanisms to deal with hazardous substance-related claims is that there are (or will be) large numbers of persons with demonstrable injuries or diseases resulting from exposure to hazardous substances who are not being (or will not be) compensated under current law.

We are unable to find, in our loss and expense experience or elsewhere, any evidence that current legal remedies are failing to provide adequate redress to persons eligible to make claims for injuries resulting from exposure to hazardous substances.

(In a few States, anachronistic statutes of limitation still pose procedural barriers to claims in long-latency disease cases in both occupational (workers' compensation) and non-occupational contexts, but the number of such States is dwindling rapidly.)

Indeed, our experience suggests that the success rate of claimants under both workers' compensation and the tort system in hazardous substance-related cases is improving steadily, as innovative counsel develop, and sympathetic courts adopt, new theories of liability. Case names that send shudders through underwriters' frames -- Borel, Sindell, Bichler and Beshada, to list only four -- are ample evidence of this trend.

But neither we, nor anyone else that we know of, can determine how many persons with demonstrable injury resulting from exposure to hazardous substances are not availing themselves of current legal remedies. Anecdotal evidence (e.g., the paucity of claims under California's 1981 Hazardous Substance Compensation Account) suggests that the number is extremely small, but the proponents of legislative change (e.g., the Superfund Section 301(e) Study Group, the Environmental Law Institute) have assumed that the number is (or will be) large.

Insurers are prohibited by law and the demands of competition from basing their pricing decisions on speculation. While the past has not always been a reliable clue to the future, we have thus far survived looking only backward. We think the Congress would be wise to take a leaf from our book on hazardous substance compensation legislation, and postpone action until there is hard and consistent evidence that it is needed.

We also think that Congress should be concerned about the insurability of those who may be required, in whole or in part, to fund any system it ultimately creates. Insurers apportion commercial insurance premiums among policyholders primarily on the basis of their loss history, thereby assuring that those who cause harm ultimately pay for it, and providing a marketplace incentive for loss prevention. An uninsurable system funded by a tax would be blind to variations in corporate conduct and would remove any incentive to invest in safety.

Moreover, an uninsurable compensation mechanism would be like a new car without an engine: it would look great, but it wouldn't get you anywhere.

Unfortunately, virtually all of the hazardous substance compensation proposals advanced in the Congress to date are uninsurable. Whether they create a private right of action, a non-fault compensation mechanism, or (worst of all) both, these bills, to one extent or another, would so weaken the evidentiary and burden of proof requirements of the common law as to cast upon defendants and their insurers the impossible task of identifying which of the millions of Americans with long-latency diseases and other health problems did not contract them through exposure to hazardous substances and therefore are ineligible for compensation.

In exactly the same fashion as the 1976 Swine Flu Immunization Program did, these bills would so broaden the potential class of eligible claimants as to render previous insured loss and expense experience useless to insurers trying to predict the costs the bills would impose on industry.

Beyond unpredictable costs, we see in many of the pending proposals a serious threat to efforts to prevent harm from occurring. To the extent that they would (1) compensate those who do not deserve to be compensated as well as those who do; (2) assess costs against chemical feedstock manufacturers and hazardous substance handlers with no regard for their conduct as corporate citizens; (3) abandon legal principles long regarded as fair and evenhanded; and (4) impose no controls either on the number of those eligible to recover or on the amount of individual recoveries, these proposals would entirely eliminate the incentives that most States' tort law provides to business to invest in safety and to prevent harm from occurring. Let me address each of these points.

First, overinclusivity. Many of the pending proposals would dramatically weaken the common law's barriers to the admissibility of irrelevant or prejudicial evidence on questions of disease causation. Some not only would permit the introduction of such evidence, but also would allow that introduction to create a rebuttable presumption in favor of the claimant or plaintiff on the crucial disease causation issue.

Questions of fairness aside for the moment, consider the implications of these changes in the context of the manner in which most hazardous substance-related claims are likely to arise -- as a result of surveillance by the Centers for Disease Control (CDC) and/or the Agency for Toxic Substance and Disease Registry. Such surveillance would typically result in the discovery of an incremental increase in the historically expected morbidity or mortality rate from a given disease in a given locality. If, upon investigation, a particular hazardous substance in the water supply were implicated in the excess illnesses or deaths, how would it be possible under the new rules to determine which of the expected and excess illnesses or deaths resulted from ingestion of the substance?

Moreover, the smaller the incremental increase in expected morbidity or mortality, the larger would be the class of persons whose illnesses and deaths were plainly not caused by ingestion of the substance, but who, by virtue of the relaxed causation requirements, would be eligible for compensation. For example, if historical mortality from liver cancer of 100 persons per year increased by only two percent in a given locality, and a hazardous substance in the local water supply were implicated in the excess deaths, only two of the 102 estates involved would be theoretically eligible to make claims, but, in actual practice, it would be impossible to deny claims from all 102 estates, since all the decedents ingested the substance.

Under ordinary common law rules, the burden would fall on the members of the class to demonstrate, by a preponderance of the relevant evidence, which of the deaths, if any, resulted from disease caused by ingestion of the hazardous substance. Most of the class, and perhaps all, would be unable to sustain this burden. If none could, then perhaps injustice would result to the estates of the two decedents who might, in fact, have contracted cancer as a result of ingesting the substance.

Under some of the pending proposals, however, it would be the defendant's burden to show which of the 102 decedents he did not cause to contract cancer, and he would be required to rebut a presumption of causation arising in part from the mandatory admission of possibly irrelevant and perhaps prejudicial evidence. If he could not overcome this presumption, then all 102 members of the class would recover, despite the fact that both they and the defendant know that 100 of them deserve nothing from the defendant. Is this not a greater injustice?

If you say it isn't, and that massive overinclusivity of the remedy is the price society must pay to make sure that the deserving two are compensated, then we submit to you that such a remedy would be tantamount to a national health insurance system for all sufferers of long-latency diseases, and that its costs would be beyond calculation.

We also submit to you that such a remedy would rob the chemical industry not only of its money and its capacity to compete in international commerce (and therefore to provide jobs), but also of any incentive to invest in safety research and technology, for "victim compensation" would bear no relationship whatsoever to harm actually caused by defendants.

If you say that such a system would be an injustice to defendants, but that deserving claimants should be compensated nonetheless, does that not suggest the absurdity of trying to convert the tort law from a mechanism for the adjudication of individual conduct into a mass compensation system?

Second, assessment of costs. The concept of cost internalization is based on the theory that the conduct of an enterprise can be favorably influenced by requiring it to absorb the costs of the harm it causes. The corollary of this concept is that the conduct of an enterprise can be unfavorably influenced by requiring it to absorb either more or less than the costs of harm it causes.

If the costs of an overinclusive "victim compensation" system were imposed solely on those enterprises producing or handling hazardous substances, those enterprises would be required to internalize many times the costs of the harm they actually cause. This not only would be patently unfair, but would so unhinge the relationship between responsible conduct and the imposition of liability as to make investment in loss prevention and safety research a waste of money. Is this really the price our society wants to pay for "victim compensation"?

Third, the abandonment of traditional legal principles. The premise of the Superfund Study Group's characterization of the common law as "inadequate" in toxic tort cases was the assumption that difficulties in establishing proof of causation by the traditional preponderance of the evidence would prevent deserving claimants from recovering for their hazardous substance-related harm. We see no evidence to support this assumption in current toxic tort litigation.

But if one concedes, for the sake of argument, that there is some basis for this assumption, what should be done about it?

The Study Group correctly identified the problem of proving causation in toxic tort cases as a matter of science, rather than of law, but sidestepped the awkward, yet patently obvious, conclusion that dealing with the incapacity of most current scientific techniques to establish causal links between exposure and disease will take enormous amounts of both time and money. The Study Group instead proposed to paper over the evidentiary inadequacy of current scientific data by rigging the legal framework into which it would be introduced so as to give it presumptive legal weight in favor of claimants and to thrust upon defendants the burden of overcoming a presumption of causation.

Most of the pending bills adopt variations of this approach, and they would both encourage the debauchery of science by making even evidence which only "tends" to show causation admissible on that issue, and debase the law by reversing the fundamental principle of our system of civil justice, that a defendant is presumed innocent until proved liable.

From an insurer's perspective, the more radically a statutory cause of action or compensation mechanism for alleged victims of "toxic torts" departs from traditional common law rules and procedures, the more difficult it will be for insurers to enter or remain in the market for environmental liability insurance.

Environmental tort liability is insurable, and insurance against such liability is currently affordable, primarily because the tort system does not compensate everyone who is injured merely because he is injured. A plaintiff must establish the defendant's liability by enough evidence to convince a judge or jury that it is more likely than not that the defendant's conduct was the proximate cause of the plaintiff's harm.

Except in the area of product liability, tort law is a seamless fabric, in that the same basic procedural and evidentiary requirements pertain in any claim, whether for automobile accidents or for hazardous substance injuries. A tug at the thread called burden of proof, undertaken to deal with a narrow range of potentially difficult claims, would undo the entire fabric, as enterprising lawyers beseech sympathetic judges to apply the precedent in other tort claims for the sake of restoring the tort law's traditional procedural uniformity.

Similarly, it is unrealistic to believe that liberal evidentiary rules in "tier one" of the Study Group's proposed system would not find their way into "tier two" tort claims, with totally unpredictable results.

No matter what legal mechanism is used to resolve toxic tort claims, the shortcomings of science will prevent the system from answering most causation questions with the certainty the law currently demands. And these shortcomings will never be fully overcome, not only because there is no one "cause" for most long-latency diseases, but also because of the sheer volume of chemicals in our environment and the moral infeasibility of treating humans as laboratory animals. But the prospect of imperfect scientific solutions to proof of causation problems should not become the basis for abandoning legal principles that our society has long regarded as fair and evenhanded. It seems to us that a higher priority should be given to bettering our understanding of human reactions to the chemicals in our environment.

We and others have repeatedly proposed, as an alternative to ill-advised tinkering with our legal system, the establishment and funding of a mechanism whose responsibility it would be to identify and document cause-and-effect relationships between certain durations and intensities of exposure to specific substances and the development of particular diseases. We are encouraged by the recent creation of the Agency for Toxic Substances and Disease Registry.

Fourth, and finally, controls on aggregate claim frequency or individual recoveries. The only plausible rationale for change in current law is the observation by the Study Group that the difficulty and expense of bringing lawsuits make the tort system an "inadequate" remedy for persons who believe their relatively minor injuries and/or damages resulted from exposure to hazardous substances.

The observation is correct, of course, but it is applicable to the victims of all kinds of injuries, not just toxic torts. The tort lawsuit is not, and was never intended to be, the vehicle for the resolution of all claims. Even among those who make use of it, only about half are awarded damages against defendants. Most tort claims are settled, with or without payment, outside the courtroom.

If it is the goal of the advocates of change to deal with the problems of potentially large numbers of persons with relatively minor losses, the tort system is the worst possible starting point for a compensation mechanism. Yet virtually all of the pending victim compensation proposals seek either to convert the fault-based system of tort law into a nearly non-fault compensation mechanism through corruption of its evidentiary and burden of proof requirements, or to piggyback the traditional tort remedy on top of a non-fault compensation program.

The plain goal of these proposals is to provide _all_ hazardous substance victims with the best of both non-fault and fault-based remedies: eased evidentiary burdens coupled with generous awards. As laudable as this objective may be in theory, it cannot realistically be achieved if the system's costs are to be controllable, predictable, and, ultimately, insurable.

We _know_, from experience with State auto insurance laws that sought to mate non-fault compensation programs with fault-based tort remedies, that the two systems are inherently incompatible. It is not possible, at one and the same time, to compensate _all_ injured persons without regard to fault _and_ to give them the generous damages that the tort system occasionally awards to _some_ plaintiffs. There simply has to be a choice between the two extremes: either _everyone_ receives _limited benefits_ without regard to fault, or _the few_ who prove another party at fault receive _unlimited damages_.

Unfortunately, the composition of the Study Group guaranteed not only that this necessary choice would not be made, but also that its "compromise" approach would be among the most expensive of the conceivable options. Essentially, the Study Group's proposal would permit claimants with long-latency diseases to recover, under unbelievably lax "Tier I" evidentiary and procedural rules, damages for which they have already been reimbursed from private sources, and to turn the entire proceeds of their administrative awards over to their attorneys to finance "Tier II" lawsuits for pain and suffering and other intangible damages. Let me illustrate how this would happen.

The Study Group proposed that only public sources of collateral benefits -- Medicare, Social Security disability, State statutory disability income programs, etc. -- be deducted from "Tier I" awards, and that "Tier II" tort plaintiffs be faced with the possibility of paying defendants' legal costs only if their tort damage awards were less than 125 percent of their administrative recoveries.

Approximately 90 percent of Americans have private health insurance protection, and the overwhelming majority of working Americans have employer-provided sick leave and wage continuation benefits. Under the Study Group's "Tier I" proposal, none of these benefits would be considered in calculating administrative awards.

Thus, if a typical American worker were to allege, under a Tier I proceeding, that his disease was the result of a non-occupational hazardous substance exposure, and the defendant (or a fund) were unable to overcome a rebuttable presumption to this effect, the administrative agency would be required to award the claimant all of his $10,000 in medical expenses and $5,000 in lost wages, (assuming these were within the maximum permitted under the system), without consideration of the fact that his private health insurer will cover all of the medical bills and his employer will cover most, if not all, of his wage loss.

Having received his administrative award of $15,000, and having turned his unpaid medical bills over to his health insurer, the"Tier I" claimant can afford, at no loss to himself, to advance the entire award to his lawyer to finance (at no cost to the lawyer) the expert testimony and other expenses necessary to maintain a "Tier II" lawsuit for pain and suffering against a defendant who has already paid, through taxes or subrogation (or both!), the costs of the administrative award.

Since the Study Group proposed no limitation on a "Tier II" plaintiff's ability to plead damages already reimbursed in "Tier I," (recommending only that a plaintiff be required to reimburse the "Tier I" system out of any tort proceeds), and no variation from the traditional "collateral source rule" in "Tier II" proceedings, the plaintiff's lawyer may plead $15,000 in "special" damages, or economic loss.

In most jurisdictions, "general" damages -- pain and suffering and other non-economic losses -- are calculated as a multiple of (anywhere from four to eight or nine times) "special" damages. Assuming general damages of five times special damages, our well-financed plaintiff could win a tort judgment of $90,000 -- $15,000 in special damages and $75,000 in general damages.

Out of this judgment, the gratuitous $15,000 advanced by the "Tier I" mechanism for expert witness and other costs of the lawsuit would be repaid, the lawyer would take his $30,000 contingent fee, and the plaintiff would pocket $45,000, tax-free and clear.

Now, if the "Tier I" system were to require the deduction of all collateral sources of benefits, paid or payable, from administrative awards, and the statute were to prohibit the pleading, in a "Tier II" proceeding, of any damages reimbursed by these sources or in a "Tier I" proceeding, the "Tier II" picture would be quite different.

In our hypothetical, the Tier I claimant would be awarded only that portion of his medical expenses and wage loss not covered by his health insurer or his employer, and would be able to plead none of these benefits as damages in a "Tier II" proceeding, a fact that would end the lawsuit before it began.

If the Congress believes what the Study Group assumed -- that there are large numbers of persons suffering hazardous substance-related injuries too insignificant to make pursuit of a tort remedy economically feasible -- and wishes to create an administrative remedy for these persons as an alternative to the tort system, we suggest that it consider building into that remedy two safeguards against its abuse: (1) a mandatory deduction of all paid or payable collateral benefits from administrative awards; and (2) a prohibition against the introduction in a subsequent lawsuit of any damages reimbursed or reimbursable by any other source, including the administrative system.

In this fashion, a "victim compensation" bill could be limited to its intended purpose and prevented from becoming either a backdoor national health insurance program or the greatest engine for tort litigation since the advent of the contingent fee.

A similar result could be achieved by requiring claimants to make an irrevocable election between the two remedies, so long as all collateral resources, paid or payable, are deducted from administrative awards.

We thank you for your consideration of our views, and would be pleased to answer your questions.

STATEMENT OF SHEILA L. BIRNBAUM

Representing the American Insurance Association

before the
Subcommittee on Investigations & Oversight
of the
Committee on Public Works and Transportation
U.S. House of Representatives
concerning
Compensation of Persons Alleging
Injuries or Diseases Resulting from
Exposure to Hazardous Substances

July 27, 1983

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to speak with you today as counsel representing the American Insurance Association. The American Insurance Association is composed of more than 160 publicly owned insurance companies providing property and casualty coverages -- indeed, presently providing the majority of general commercial liability insurance in the United States. It is likely that the members of the American Insurance Association will be asked to provide insurance in the future for companies subject to liability to those who claim injury as a result of exposure to hazardous substances. The members of the American Insurance Association, and other insurers, have responded in the past to the emerging environmental liabilities; new coverages have been developed and competitively marketed. As Congress proceeds to investigate approaches to the compensation of victims of hazardous substance exposure, the American Insurance Association has an interest in seeing that the system as it develops is reasonable, equitable and insurable.

The general concerns of the American Insurance Association in this area have been made known to you through their position paper, dated July 12, 1983, which I understand you have already received. That position paper addresses comments both to the pending legislation generally, and specifically to certain recommendations made by the majority of the CERCLA Section 301(e) Study Group.

I wish to focus my remarks today on two legal principles which form the centerpiece of the Study Group majority's recommendations: first, its recommended presumption that a disease or injury resulted from exposure to hazardous chemicals when no proof of that fact is available; and second, its proposal to use a formulation of strict liability which leaves no room at all for the traditional notion that a party at fault pays for the damage it causes.

The Presumption of Causation

The Study Group majority recommended that in its proposed administrative proceeding, a claimant be afforded a presumption of causation upon a showing that his disease was of "the kind" which is "known" to be caused by a particular chemical to which he was exposed. The fund would be entitled to the same presumption in any subrogated proceedings to recover against a private company.

As a practical matter, this presumption makes private industry the guarantors of the health of large segments of the population at large. Many of the diseases which are alleged to be caused by hazardous substances -- for example, cancer -- are thought to have many possible causes. Claimants who can show that they were exposed to any particular carcinogen would be able to shift the burden to the defendant to prove that chemical did not cause the disease. Although the particular cancer might have been caused by other chemicals, smoking, diet, overexposure to sunlight, repeated irritation, or combinations of these and other factors, it would be all but impossible to prove that the particular chemical at issue did not cause this claimant's cancer. After all, the claimant, and not the defendant, is in possession of the facts concerning the onset of disease and the symptoms involved, personal diet and habits (such as smoking) that might be other causes of the disease, and all background information concerning the claimant's history and exposure to this or other hazardous substances. Yet despite claimant's possession of the relevant facts, the Study Group majority's proposed presumption would defy traditional principles of proof and place an impossible burden of disproof on the defendant.

As a result of this scheme, the defendant would be required to pay, not only for any cases of cancer caused by the release of the particular carcinogen, but also for all other cases of cancer that may arise from any other cause in the environment or even genetically. It has been estimated that approximately 2% (and no more than 5%) of cancer deaths are caused by air, water and food pollution in all its forms;* 1% or less may result specifically from exposure to pollutants found in hazardous waste sites.**

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* See R. Doll & R. Peto, The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today, 66 J. Nat'l Cancer Inst. 1192, 1245-50, 1256 (1981); Technology Assessment Board, 97th Cong., Assessment of Technologies for Determining Cancer Risks from the Environment 91 (June 1981).

** Comments of Jim J. Tozzi at a conference on May 7, 1983 concerning Office of Management and Budget-sponsored Inter-Agency Study of Toxic Torts.

Thus, 95% or more of the damage payments that would be required to be made to those who have cancer and reside near a dump site, based on this presumption of causation, would be for cases not caused by any chemical released by the defendant.

Further, although the Study Group majority itself only recommended the use of this presumption of causation in proceedings for administrative awards and resulting subrogated proceedings by the fund to obtain indemnity from private companies involved, the likelihood is that this approach would find its way into the common law in time. Thus, in addition to medical expenses and lost earnings, pain and suffering awards would also be based on the presumption, despite the fact that a very large percentage of such awards should never be made because the injury or disease was really due to other causes.

This result is inequitable; it is also unwise. To fund what amounts to a social health scheme by loading the entire costs onto the chemical or oil industries -- especially in the face of foreign competitors who are not burdened by such staggering costs -- could prove disastrous to vital American industries.

"Strict Liability"

The Study Group majority recommended that all consideration of fault be eliminated in assessing liability against defendants. This is a radical departure from traditional legal principles. Even under the principles of "strict liability" as applied today in many courts, and as embodied in the Restatement (Second of Torts §§ 519-52, some evaluation of the conduct of the defendants remains an integral part of the decision of any court as to whether or not it should impose liability "without fault." The recommendations of the Study Group majority, however, would not permit the courts or administrative tribunals to consider the good or bad conduct of the defendant and, therefore, would not encourage companies to act carefully in handling hazardous waste.

The traditional reasons for imposing liability on defendants who are in some way "at fault" are two-fold: 1) it comports without notions of fairness, and 2) it provides an incentive for the defendant and others to behave properly in order to avoid liability. A failure to consider conduct would remove incentives for industry to behave well. Under the Study Group majority's recommendations, the cost penalties would be assessed regardless, and so there would be no point (from industry's standpoint) in spending time or money "up front" to be careful or to act wisely. Such a result would be a national tragedy, since surely it is wiser to encourage industry to prevent harm in the first place.

This result is exacerbated by the Study Group majority's other recommendations. For example, the fact that a defendant can be jointly and severally liable without regard to fault, means that a very prudent manufacturer who merely had the misfortune to place its waste in the same disposal site as another company which acted recklessly, or even criminally, could nonetheless be held liable for the entire judgment. Given the operation of the Study Group majority's proposed presumption of causation, discussed above, a prudent manufacturer might be held liable even though the entire harm was caused by the missing, negligent manufacturer. If the negligent enterprise cannot be found, or is judgment proof, the prudent manufacturer will have no recourse for contribution or indemnity. Thus, the care taken by the "good" company will be of no avail whatsoever.

Further, the Study Group majority suggested that the administrative recovery mechanism be funded initially by a tax on certain industries. Once again, such a tax would fall on the heads of "good" and "bad" actors alike, imposing hughe financial burdens on private industry without providing any incentive for proper, careful behavior.

If Congress feels that there should be compensation for all injured persons who contract cancer or other diseases that might be caused by hazardous wastes, it should consider an effective method for doing so. The costs of these benefits ought not be levied in such a way as to leave no incentives at all for those who act responsibly. We have all benefited by obtaining the products, the high standard of living, and the relatively longer and healthier lives that modern industry and society have afforded. Although those who have negligently or recklessly disposed of waste products should certainly pay any victims who have been injured by their acts, the huge costs of a broad compensation scheme should not be placed on a small segment of American industry without regard to fault.

Conclusion

Our traditional legal principles have been based on concepts of justice and fairness. Any wholesale, radical abandonment of these principles runs the risk of seriously affecting the goals of justice and accident prevention that have been built into our tort law. The Study Group majority's recommendations are not only poorly thought out in the context of "toxic torts", as we have seen above, but they also run the distinct risk of weakening the overall fabric of tort law in other, unintended areas. I respectfully suggest that considerably more thought and care must be expended by Congress, academicians and others before any solution to the toxic tort problem is adopted. Irresponsible "solutions" to our perceived problems may turn out to be worse than the problems they seek to cure.

AN EXCERPT FROM: AMERICAN INSURANCE ASSOCIATION. PRELIMINARY PAPER ON PROPOSED HAZARDOUS SUBSTANCE VICTIM COMPENSATION LEGISLATION, JULY 12, 1983. SUBMITTED TO THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT OF THE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION, U.S. HOUSE OF REPRESENTATIVES.

I. INTRODUCTION

The American Insurance Association is a trade association composed of more than 160 publicly owned insurance companies providing property and casualty coverages. The Association's members provide the majority of general commercial liability insurance in the United States. It is likely that the members of the American Insurance Association will be asked to provide insurance for those subject to liability for hazardous substance compensation. A market for such insurance can develop only if the compensation liabilities to be insured are both reasonably predictable and affordable. The members of the American Insurance Association, and other insurers, have responded in the past to the emerging environmental liabilities; new coverages have been developed and competitively marketed. Thus, the American Insurance Association has an interest in seeing that the liability system as it develops is reasonable, equitable and insurable.

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B. Proponents' Failure to Consider the Staggering Costs of Their Overinclusive Proposals

It would be disastrous to structure a radical new "solution" in such a way as to eradicate the traditional tort law requirements that a plaintiff show a defendant was at fault and caused the harm complained of.* Such a "solution" would, in effect, require the chemical and oil industries to pay the costs of cancers, tumors, genetic damage, joint pains, headaches and other diseases or symptoms every time a claim of "exposure" to toxic waste was lodged, even if (as would almost always be the case) the claimant's disease resulted from a combination of other causes such as normal environmental or genetic factors unrelated to exposure to toxic waste. (See further discussion of the specific legal principles below).

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* Moreover, any "solution" that abandons these elementary principles might have serious ramifications for tort law in other areas, which no one intended to "reform."

For example, consider the present cancer statistics - just one disease that might result from exposure to hazardous substances. In 1983, an estimated 440,000 Americans will die of cancer, and an estimated 855,000 people will be diagnosed as having cancer.* Statistics show that more than 20% of the total deaths among Americans resulted from some form of cancer -- the second highest cause of death, after heart disease.** Yet, it has been estimated that approximately 2% (and no more than 5%) of cancer deaths are caused by air, water and food pollution in all its forms;* 1% or less may result specifically from exposure to pollutants found in hazardous waste sites.** However, the Study Group's proposal, echoed in many of the pending legislative proposals, would permit recovery by anyone who can claim non-occupational "exposure" to hazardous waste dumps and whose ailment cannot be demonstrated not to have resulted from such exposure -- an impossible burden for a defendant to meet, as more fully discussed below. Such a skewed system would certainly involve many times the number of recoveries than would be warranted by the small percentage of diseases arguably "caused" by hazardous substances.

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* E. Silverberg & J. Lubera, Cancer Statistics, 1983 10 (reprinted from Ca-A Journal for Clinicians, Vol. 33, No. 1, 1983 (American Cancer Society).

** Figures for 1978 (the last available year). Cancer Statistics, 1983, supra, at 11.

In light of these facts, the cost of the Study Group majority's overinclusive "solution" would be staggering. Just as with other types of compensation programs begun in the 1960s and early 1970s the costs can be expected to balloon to truly massive proportions. *See* "Toxic-Liability Bills Plant a Time Bomb of Entitlement Costs," *The Wall Street Journal*, Friday, June 3, 1983, p. 20, col. 3; Office of Management and Budget, *Compensation for Toxic Substances Exposure* (May 19, 1983). The experience under the federal Black Lung Benefits Act provides an apt warning:

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* See R. Doll & R. Peto, The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today, 66 J. Nat'l Cancer Inst. 1192, 1245-50, 1256 (1981); Technology Assessment Board, 97th Cong., Assessment of Technologies for Determining Cancer Risks from the Environment 91 (June 1981).

** Comments of Jim J. Tozzi at a conference on May 7, 1983 concerning Office of Management and Budget-sponsored Inter-Agency Study of Toxic Torts.

> "The Black Lung Act provides an example of what can happen when a compensation system is not well thought out. A General Accounting Office report issued in January 1982 found that 84 percent of claims were paid without adequate medical evidence.
>
> The result: In 1969, Congress estimated that the total program would cost between $40 million and $385 million. By 1972, costs to the federal government alone amounted to $33 million per month. In 1979, such costs amounted to $1.5 billion and reached $2 billion in 1982. The total cost of the program, including benefits paid directly by industry, is unknown."*

As a result, in 1981 Congress eliminated many of the presumptions of causation in the Black Lung Act because they had "led to an excessive number of claims and vastly greater expenditures than had been anticipated." (Report at 228). Black Lung Act costs are expected to level off or slightly decrease over the next few years.* Nonetheless, one critical presumption remains -- a rebuttable presumption that certain identified diseases were work-related if the employee could show 10 years of employment. Consequently, costs will not decline very quickly, and in fact continued to rise in 1982.**

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* J.B. Browning (Chemical Manufacturers Association), *Public Compensation: A Chemical Industry Perspective* 9 (April 5, 1983); *see* *Problems Relating to the Insolvency of the Black Lung Disability Trust Fund: Hearings Before the Subcomm. on Oversight of the Comm. on Ways and Means of the House of Representatives*, 97th Cong., 1st Sess. 2-15, 159-88 (1981).

The Black Lung Act is very limited in scope; costs for a sweeping hazardous substance program would be enormous, given the broad presumptions, unlimited awards and huge administrative costs inherent in the pending proposals.

To obtain a rough concept of this cost, assume that the number of cases that would be filed for all the types of diseases which plaintiffs may claim could result from exposure to hazardous substances -- cancer, respiratory ailments, tumors, genetic defects, coronary disease, etc. -- might be so low as one-fourth of the diagnosed annual number of cases of cancer alone. Rounding downwards, such an assumption yields an incidence of approximately 200,000 claims filed per year.*

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* Office of Management and Budget, Compensation for Toxic Substances Exposure, Chart 2 (May 19, 1983).

** Id. Further, the use of a presumption that a disease is work-related in the context of the Black Lung Act or workers' compensation statutes is inherently a limited one; the list of employees on the roster is finite and easily ascertainable. Such a presumption relating to hazardous substance exposure is open-ended, uncontrollable and potentially limitless in scope.

At this conservatively estimated rate of claims, and given the same average recovery in Tier One that is estimated for current workers' compensation cancer cases of $130,000 per award,** the Study Group's program would result in an annual cost of $26 billion in Tier One claims payments alone.*** Assuming allocated loss adjustment expenses (i.e., defense legal fees, etc.) of approximately 10% added to the total cost of these cases,* the annual bill in Tier One alone might be on the order of approximately $28 billion.

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* In view of the claims of the Environmental Protection Agency ("EPA") and legislative proponents, this number of cases is entirely within the bounds of possibility. EPA has claimed there are over 80,000 sites in the nation with contaminated surface impoundments, 90% of which "are believed to pose at least a potential threat of ground water contamination." Technology Assessment Board, 98th Cong., Technologies and Management Strategies for Hazardous Waste Control 5 (March 1983). Under the Study Group majority's approach, residents around these sites showing "exposure" may be able to recover, even where such "exposure" did not actually cause their disease or injury.

** Source: National Council on Compensation Insurance. See Technical Appendix A.

*** I.e., 200,000 claims times $130,000 per award. To put this annual cost in perspective, it represents more than twice the total workers' compensation loss and loss expense incurred by private carriers and state funds in 1981 (almost $12 billion), and would

(Footnote continued)

Additional awards to plaintiffs in Tier Two would add massive costs such as pain and suffering awards, attorneys' fees and litigation expenses. To the extent this estimate is conservative in its assumptions, it follows that the actual cost of the program will run even higher.

To require that this extraordinary cost -- far in excess of any proven level of injuries caused -- be shouldered by a few American industries would seem very

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(Footnote *** continued from previous page)
add 7.0% to the inflation rate of chemical and petroleum product prices (given 1982 sales of $371 billion), along with a similar effect on the prices of all other goods and services that incorporate these products, if an industry tax were passed through to consumers.

* The National Council on Compensation Insurance figures showed allocated loss adjustment expenses of 10%, but it is reasonable to expect that for cases proceeding on through Tier Two litigation, such expenses would be three to four times higher. The Study Group majority's proposal provides no abatement in these transaction costs, since plenary court lawsuits are not barred; indeed, the Study Group's proposal merely adds the administrative costs to the present system.

unwise, especially in the face of foreign competition which would not be burdened by similar costs. See Letter dated March 10, 1982 by Study Group Member George C. Freeman, Jr. (included in Volume 2 of the Report). In addition, as the cost of complying with the law rises, the incentive to engage in illicit, secret dumping or to employ other illegal means of waste disposal rises.* Further, to assume that such an extraordinarily costly scheme is insurable, or worse yet to dismiss the issue with the Study Group majority's assertion that:

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* Concern has already been expressed that organized crime may be involved in the garbage and waste disposal industry. See, e.g., "Corruption Cited in Waste Business," New York Times, Sunday, May 1, 1983, at A52, col. 4; "Attorney Denies Dumping, Mob Connection," UPI Regional News story, Friday, April 29, 1983; "Poison Dump Stirs Alarm in Poconos," New York Times, Sunday, April 24, 1983, at A20, col. 1. As the New York Times reported last year in connection with the conviction of Russell W. Mahler:

> "New York can handle only 60 percent of the 1.4 million tons of industrial waste that companies in the state produce annually, and the pressure to get rid of some of it by illegal means is tremendous, according to state officials. 'If you pay the price, you can dispose of hazardous waste, but the price can be prohibitive,' said Jeremiah B. McKenna, counsel to the State Senate's Select Committee on Crime."

Chavez, "Toxic Waste Entrepreneur," New York Times, Thursday, May 27, 1982, at D1, col. 1.

> "insurability is not the sole or even the dominant factor that ought to determine whom the law protects and how,"*

is to court disaster. If no insurance were written to cover these risks, or if industry is unable to afford the premiums, there would be no effective means of spreading the enormous cost of the proposed system while at the same time offering the incentives to careful conduct that are traditionally provided by variable commercial insurance rates. Without insurance, it is unclear that our vital industries would even be able to meet this level of risk without jeopardizing their very existence. Unfortunately, this is precisely the perilous course which the Study Group majority, and proposed state and federal legislation modelled on its recommendations, would have us adopt.

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* Report at 185. See Letter dated May 17, 1982 from George C. Freeman, Jr. (included in Volume Two of the Report), which questioned the availability of insurance to cover the Study Group's proposals.

TECHNICAL APPENDIX A

Estimation of Average Claim Costs for Workers' Compensation Cancer Cases

The National Council on Compensation Insurance (NCCI) has estimated the current average cost of a worker's compensation cancer claim to be $130,000 based on data for claims which have already been filed, as explained below.

Worker Benefits

A review of reported workers' compensation cancer cases showed that the typical claimant was a fifty year old male who lived for three years after he became disabled and incurred medical expenses approximately equal to his wage loss benefits during that period. The costs of these claims were calculated using current wage rates so that no adjustment for inflation was made.

Survivor Benefits

Existing rules allow for the worker's widow to continue receiving benefits after his death for a duration of up to ten years unless she dies or remarries prior to that time, whereupon benefits cease. Widow's benefits were limited according to these rules using standard mortality tables and the results of an NCCI remarriage study which provided distributions, by age, of the number of women expected to die or remarry in each subsequent year.

AN EXCERPT FROM THE
ORAL STATEMENT OF BRUCE W. KARRH, M.D.
ON BEHALF OF THE CHEMICAL MANUFACTURERS ASSOCIATION

BEFORE THE SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS,
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
UNITED STATES HOUSE OF REPRESENTATIVES, JULY 21, 1983

Mr. Chairman, members of the subcommittee, my name is Bruce W. Karrh. I am the General Director of Medical, Safety and Fire Protection for the Du Pont Company. I am appearing today on behalf of the Chemical Manufacturers Association (CMA), a non-profit trade association whose company members represent more than 90 percent of the productive capacity of basic industrial chemicals in this country.

We appreciate the opportunity to present our views on the compensation of persons injured by exposure to hazardous substances. This is an important subject and we are taking a constructive role in reaching sound public policy on this issue.

CMA strongly believes that individuals harmed by exposure to hazardous substances should be compensated by those who have caused their injuries. We are concerned about anyone injured from such exposures and we support the right of an injured individual to receive fair and speedy compensation. However, as I will discuss, we have not seen evidence of a significant health problem from hazardous wastes. We fully agree that concerns in this area require a thorough scientific review, but we also believe that in view of the review processes now moving forward, it would be precipitous for Congress now to enact pending proposals to modify existing compensation systems.

Compensation for non-workplace injuries traditionally has been handled through the common law tort system of the various states. It has recently been asserted, however, that new approaches are needed because the existing tort law system is inadequate to deal with waste site injuries.

These assertions are based on the assumption of a major public health problem from waste sites. Proponents of this view have assumed that large numbers of people are being harmed by waste sites and that the existing legal system will not be able to handle massive numbers of claims to provide redress to those injured. However, this fundamental assumption of widespread harm from waste sites has not been closely examined.

Last year we created a special work group to determine if there was a relationship between waste sites and widespread harm. I served as chairman of this work group. We found that claims of such a relationship run counter to the experience of CMA member companies. Moreover, independent epidemiological surveys have failed to detect significant health problems.

In my testimony today I will share information that led CMA to this conclusion. I also will describe what CMA is doing to increase our knowledge about potential health problems resulting from waste sites. In particular I will report on two recent developments which should provide needed data and analysis upon which more informed judgments can be made in the future.

Epidemiology Surveys And Other Studies

In our consideration of the issue, we found only two valid epidemiology surveys of populations relative to waste disposal sites. The first was a study conducted by the New York Department of Health to determine whether the population in

Niagara Falls, New York, which could have been exposed to wastes from the Love Canal site, had suffered any increased incidence of cancer. The data employed in this epidemiology study was obtained from the New York Cancer Registry for the period 1955 through 1977. The Department of Health concluded that the data showed no evidence of higher cancer rates associated with residence near the Love Canal site than in the entire state outside of New York City. Cancers reviewed included respiratory cancer, liver cancer, lymphoma and leukemia. The only increased incidence noted was for respiratory cancer, but the incidence in the population surrounding Love Canal was not significantly different from the rest of Niagara Falls. Thus, it was concluded there was no evidence that the lung cancer rate was associated with toxic wastes. Moreover, despite earlier assertions, a recently released study by CDC has not found an increase in chromosomal damage in Love Canal residents when compared to residents elsewhere in Niagara Falls. The study reported no increase in abnormalities among residents or former residents of the area surrounding the canal when compared to residents away from the site.

The second study we looked at investigated the health effects, on the general population, of chemical exposure in highly industrialized Contra Costa County, California. This 4-year study, which was conducted by the California Health Department Cancer Epidemiology Unit, was financed by both state and federal funds. It found that smoking, and not air pollution or chemical exposure at work or from dump sites, was the most likely explanation of higher rates of lung cancer in Contra Costa County.

Thus, the only epidemiology studies known to us which scientifically analyzed the effects of chemicals from waste disposal sites in the surrounding community suggest no causal link between proximity to the sites studied and cancer incidence.

We have also reviewed a study of residents living in Hardeman County, Tennessee, who used water from a contaminated aquifer. The study found that blood tests for some of the residents displayed a temporary abnormal liver function which, in most cases, disappeared with the removal of the source of exposure.

We also reviewed a number of studies conducted by the government and by industry to determine whether occupational exposure to toxic chemicals has resulted in an increased incidence of chronic disease. Based upon our own experience and the available exposure data, we believe that, in general, such employees would have been exposed to higher concentrations of chemicals than the population around waste disposal sites. Hence, occupational exposure and health data should provide an indication of the health effects that might be expected if similar exposure patterns were encountered by the public. Since we saw no significant increased incidence of chronic disease among employees in the chemical industry, we concluded that widespread increased incidence of chronic disease among the public is also unlikely. Our studies have also found that chemical workers have a lower death rate from cancer and from all causes combined than the general public.

For these reasons, CMA's view is that evidence of a national problem deriving from public exposure to hazardous waste is not at hand. CMA also believes, however, that further scientifically sound information is needed. We also know the public needs reassurance that measures are underway to resolve the questions that have been raised. However, since we have seen no evidence of significant health effects, we have time to do the studies required.

TESTIMONY OF KHRISTINE L. HALL

BEFORE THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
HOUSE PUBLIC WORKS COMMITTEE
JULY 27, 1983

Mr. Chairman, members of the Subcommittee, my name is Khristine L. Hall. I am an attorney with the Toxic Chemicals Program of the Environmental Defense Fund. Thank you for inviting me to testify on the issue of compensating victims of exposure to toxic substances.

The Environmental Defense Fund (EDF) is a national not-for-profit environmental organization with a nationwide membership of approximately 47,000. The goal of EDF's Toxic Chemicals Program is to minimize or prevent exposure by people and the environment to toxic chemicals. Over the past decade, EDF has worked to insure proper implementation of a number of regulatory programs concerning toxic chemicals: the Food, Drug and Cosmetic Act, the Clean Water Act, the Clean Air Act, the hazardous waste provisions of the Resource Conservation and Recovery Act, and others. Most recently we have been actively involved in implementation of the Comprehensive Environmental Response, Compensation and Liability Act (Superfund). Our work on these programs, especially on Superfund, has aroused our concern about the ability of people who are injured by exposure from toxic substances to be compensated for those injuries.

Discussions of the important issue of providing a better mechanism than now exists to insure compensation to those people who have been injured by toxic chemicals has recently resumed after being curtailed by the passage of Superfund in 1980. EDF was among those organizations that worked for inclusion of a victim compensation provision in Superfund. While we understand the political necessity of dropping such provisons from the final bill to ensure passage, we remain convinced of the necessity of such a provision.

Over the past several months, I have been meeting periodically with representatives of environmental organizations, citizen groups, and other public interest organizations to discuss victim compensation. While I am not prepared today to lay out a detailed formal position on behalf of those organizations, I can state unequivocally that the environmental community strongly supports enactment of victim compensation legislation in this Congress. To allow the inconsistency of Superfund - which provides for compensation for natural resources damaged by toxic chemicals, but not people who are injured by toxic chemicals - to stand for much longer is not good public policy.

Our support for legislation is premised on (1) the fact that there are people who have been injured by toxic chemicals and (2) the current legal system presents a number of difficult and sometimes insurmountable barriers to recovering compensation for those injuries.

PEOPLE ARE BEING INJURED BY TOXIC CHEMICALS

- Out of 112 blood samples taken by the Centers for Disease Control from people living in dioxin-contaminated neighborhoods in Missouri, all 112 samples showed biomedical evidence of liver dysfunction.
- The rate of heart defects in infants born to mothers in San Jose, California, who consumed water contaminated with trichloroethane (TCA) is significantly higher than the rate in the general population.
- Many children living near a lead smelter in Deere Park, Texas have severely elevated blood lead levels - well above levels the Public Health Service defines as lead poisoning.
- Scientists have found that children in Michigan with a high body burden of polybrominated biphenyls (PBBs) in their fatty tissue have decreased intellectual capacity, as measured by school performance.
- A significant number of the rural population of Hardeman County, Tennessee that drank chemically-contaminated drinking water have symptoms including liver damage, enlarged liver, or optic atrophy

These are but a few examples of where toxic chemicals have caused injury to human beings. They are examples that have come to my attention in recent months. This is not a complete list - nor could it be, since we have only recently begun to study and document the effect of toxic chemicals on people and since some diseases caused by toxic chemicals have long latency periods.

It is enough of a sampling, however, to indicate that there are, in fact, real victims of exposure to toxic chemicals. In addition, we know that some people are exposed, through the air they breathe, the water they drink or the food they eat, to a broad range of substances that have been shown in animal tests and epidemiology studies to cause cancer, birth defects, infertility, lowered IQs, respiratory problems, and other serious illnesses. Dose levels for some of these exposures are relatively high. We cannot assume that there have not been and will not be human injuries from such exposure.

It may be many years before we can reasonably expect to have scientifically documented the full magnitude of injuries caused by toxic chemicals. Hasty studies undertaken with an eye toward pending legislation will not produce such documentation. I want to emphasize, however, that the environmental community believes we have enough evidence in hand to indicate that people are being injured by toxic chemicals. This is not a solution in search of a problem as those who created the problem so glibly assert, but a serious problem in search of a thoughtful solution.

LEGAL BARRIERS PREVENT RECOVERY OF COMPENSATION

Once the premise is accepted that people have been or will be injuried from the toxic chemicals now found in our environment, two questions should be asked: (1) What can society do to minimize or prevent exposure to these toxicants and (2) Are the victims being compensated for their injuries?

The answer to the first question lies largely in more effective regulation of the way toxic chemicals find their way into the environment. Considerable thought has been addressed to this issue over the past decade. Although improvements are in order for many of our efforts (e.g. toxic water pollution amendments pending before this Committee, the pending reauthorization of the Resource Conservation and Recovery Act, and new amendments to the Clean Air Act and the Toxic Substances Control Act), action has at least been initiated.

Unfortunately, the second question - concerning compensation - has not yet been adequately addressed. The starting point for any inquiry is the basic question of why we should be concerned about making sure that victims of toxic chemicals are compensated. It is a basic goal of our tort system that each victim be compensated by the entity inflicting harm on him or her. This goal rests primarily on the principles of fairness and economic efficiency. It is fundamentally unfair if a victim is not compensated for injuries received as a result of activities carried on by and benefiting another. Furthermore, injuries resulting from an activity are part of the social cost of that activity. If those costs are borne by someone other than the entity reaping the benefit of the activity, and more important, making the decision as to the amount of the activity, then an economic inefficiency occurs. That inefficiency could result in a level of activity at which the social benefit from the activity does not outweigh its social costs. A variant of this theory is that if a polluting entity is made to pay the full cost of the damage it causes, such economic costs may change the manner in which business is conducted.

The issue of whether a victim has been adequately compensated is thus important - both to the victim and to society. Delay in solving problems in compensation cannot, therefore, wait the many years it will take to thoroughly document the extent of the problem.

The two most authoritative documents to address this important issue of whether current remedies are adequate - the Environmental Law Institute's report entitled "Statutory Reform of 'Toxic Torts' Relieving Legal, Scientific, and Economic Durdens on the Chemical Victim" and the Superfund Section 301(e) report, Injuries and Damages from Hazardous Wastes - Analysis and Improvement of Legal Remedies," -- both conclude that our present system or tort law is inadequate to insure compensation to victims of toxic chemicals. To quote from the Section 301(e) Study Group:

> "The Study Group concludes (1) that there are causes of action on which to base a claim for damages for such injuries or damage; (2) that there are many substantive and procedural barriers to recovery; and (3) that existing courses of action and existing barriers to recovery will allow some recoveries in a number of highly selected cases. Available remedies are inadequate in view of the substantial number of claims that may arise, and the factual and legal complexities that will be involved in their litigation."

It is fair to say that our present tort system is behind times in dealing with modern society and the injuries produced in modern society. Old rules which worked well when industrialization was just beginning have been slow to adapt to the complexities of our technological age. Problems such as antiquated statutes of limitations, proof of causation, standard of liability, and joinder of defendants, as well as the general complexity of toxic tort litigation, have blocked recovery or made it so difficult as to discourage seeking it. Although progress has been made in some states on some issues, major problems remain, as a general matter, that deserve attention and solutions.

WHAT ARE THE SOLUTIONS?

Descriptions of the problem is the easy part of this controversy. Finding a meaningful, fair solution is not so easy. Several specific legislative proposals, incorporating different approaches and concepts have already been put forward in both the House and Senate side. Rather than commenting specifically on these bills, I would like to make a few suggestions and to address concepts incorporated in the bills generally and in the ELI and 301(e) studies.

A. Scope of Coverage

Victims compensation legislation should cover injury from all environmental exposures - not just from hazardous waste. Although the hazardous waste problem is dramatic and exposure to it significant, exposure to toxic chemicals through other environmental media is also important, as illustrated by the blood lead levels in children close to the lead smelter in Texas, cited above. It makes little sense for a person whose injury arises from exposure to lead from a smelter to have to follow different, more stringent rules for recovery than the person whose injury arose from a hazardous waste site. We note that Superfund coverage is not confined to hazardous waste sites and believe that victims compensation legislation likewise should be broad enough to cover all environmental exposure.

B. Two-tiered System

The Section 301(e) panel proposed a two-tiered recovery system, with the first tier being an administrative mechanism and the second tier a judicial approach. This approach has been adopted in some of the bills that have been introduced. We endorse the general concept of the two-tiered system, with reservations about details of its implementation.

1. Tier I - Administrative mechanism

As laid out in the Section 301(e) study, Tier I would establish an administrative mechanism for taking evidence from potential victims and making awards from a Fund, financed primarily by a tax on industry. We would propose that EPA administer the compensation system, but that the board or panel making findings also have representation from Health and Human Services.

We propose that recovery from Tier I be limited to lost income up to $2000 a month and reasonable out-of-pocket expenses (*i.e.* medical expenses, cost of relocation). This differs from the recommendation of the Section 301(e) panel only in allowing other reasonable out-of-pocket expenses (such as the expense of a forced relocation) to be recompensed in addition to medical expenses.

To make this process work, the burden of proof now generally required of plaintiffs would have to be eased. We recommend that legislation state that a plantiff has met his burden of proof, subject to rebuttal, by showing the following: (a) reasonable likelihood of exposure of sufficient duration and dose to produce injury; (b) scientific link between injury and exposure to chemical; and (c) injury. This is not unlike the rebuttable presumption recommendation of the Section 301(e) panel for Tier I.

In establishing the second element, the scientific link between injury and exposure, plaintiffs may rely on Toxic Substances Documents, if available. As recommended by the Sectio 301(e) panel, these documents would provide evidentiary data showing that specific hazardous substances or wastes cause specific diseases or illnesses. Because preparation of these documents is likely to be protracted and the subject of intense debate, they will undoubtedly be produced only late in the process. In addition, because of the rapid rate that scientific discoveries are now being made about toxic chemicals and their effects, these documents are also likely to be outdated when finally produced or shortly thereafter. We therefore recommend that plaintiffs be allowed to rely on other scientific evidence available tending to prove cause-and-effect or correlation between exposure to a chemical and disease. This would include epidemiological studies, animal studies, tissue culture studies, and micro-organism studies.

This approach leaves in place a very considerable burden of proof on plaintiffs. Proof of a reasonable likelihood of exposure of sufficient dose and duration to cause injury is very difficult. In many instances, it will require extensive and expensive sampling and sophisticated modeling and analysis to prove the fact of exposure and the concentrations of the pollutants -- often after-the-fact when circumstances have changed or evidence altered.

Establishing the link between exposure to the chemical and disease is also an expensive proposition, given that we doubt the widespread availability or usefulness as the ultimate resource of the Toxic Substances Document. Expensive research and analysis will also be required for this step.

Finally, establishing the medical fact of injury with certainty of diagnosis may also be expensive. As everyone is aware, any visit to the doctor is expensive. Medical attention to unusual conditions or diseases caused by toxic chemcials requires special expertise, which is even more expensive.

In short, although this proposed approach eliminates some barriers in the current system and allows the introduction of more evidence than often allowed by courts now, it still presents a very high hurdle to recovery. Hiring the necessary technical people, analysts, and expert witnesses is still very expensive - in many cases more expensive than the small amount of money proposals would allow to be recovered under Tier I.

This is an important point. What it means is the Tier I may not be used with success very often. It is for this reason that we view Tier I as a very limited remedy of limited utility. In fact, the Tier I does not even begin to address the bigger, more complicated issues associated with injury from exposure to toxic chemicals, such as pain and suffering, compensation for loss of intelligence, and compensation for loss of fertility. We support establishing Tier I as a way of dealing with very small injuries and as a means of gaining experience in this area with administrative compensation mechanisms. Given its limited utility and scope, however, it is clearly not a substitute for Tier II. We therefore vigorously oppose any efforts to limit compensation to Tier I or to force a binding choice between Tier I and II.

2. Tier II

The second tier is resort to the judicial system. The Section 301(e) panel essentially left Tier II up to the state courts, while making recommendations on ways in which state legal requirements should be changed to enhance recovery possibilities. This approach ducks the issue and is unacceptable, given the continued importance that judicial remedies will play in any viable compensation system. While some states have already adopted and other states will adopt, either through court decision or legislation, some of the reforms recommended by the Study Group, reliance on the state court system will result in a patchwork quilt of remedies, when viewed from the national perspective. Just as it as been necessary to establish minimum federal standards and guidelines as a floor for pollution control, so too is it necessary to establish minimum federal rules governing compensation systems.

It is for this reason that we recommend establishment of a Federal cause of action, incorporating reforms recommended by the Section 301(e) Study Group. To insure that the resources of our state court system continue to be used, we suggest that this federal cause of action may be brought either in the state courts or in the federal courts. There is precedent for this approach in the Federal Employers Liability Act (FELA - 45 U.S.C. §56). Plaintiff should also be allowed to use state courts and causes of acion.

There should be no limits on the amount or type or recovery. In addition, legislation should make clear that the plaintiff's burden of going forward has been met by showing the same three elements of the rebuttable presumption in Tier I: (a) reasonable likelihood of exposure of sufficient dose and duration to cause injury; (b) link between exposure and injury and (c) injury. This approach does not relieve plaintiff from proving his case by a "preponderance of evidence" as is now the usual standard in civil liability cases. Rather, it allows plaintiff to introduce moe types of evidence (such as epidemiology studies, animal studies, etc.) without challenges to relevency and relieves plaintiff of the burden of tracing a molecule of the pollutant from the source into the body to produce the injury. This burden, which traditional tort law may require, is and will remain impossible to meet. This approach allows plaintiff to take evidence relevant to modern injuries to the jury. Defendant, of course, still may introduce countervailing evidence.

As discussed above, this is still a very considerable, expensive burden of proof. Defining the burden of going forward in this manner does not mean that plaintiff will always prevail; it does mean giving plaintiff the opportunity to present his case in the only way relevant to modern injuries to the jury.

C. Liability Issues

In accordance with the recommendations of the Section 301(e) Study Group, liability for incident that causes or contributes to the injury complained of should be strict, joint and several. This standard should apply both to direct judicial actions by injured plaintiffs and to claims by the Fund subrogated to plaintiffs' claim. Strict liability is necessary so that plaintiff does not have to prove fault - an impossible burden of proof in most of these cases.

Joint and several liability is necessary because of the difficulty of locating all defendants who may have caused or contributed to the injury. Delays in the onset of disease as well as, for instance, the fact that many companies may have used the dump from which a toxic substance leaked mean that, in the words of the Section 301(e) Study Group:

> "It is impossible here, as in other instances of environmental pollution to attribute and allocate responsibilities and liabilities with specificity. Substantive and procedural rules that require such specific allocation will defeat the plaintiff's claim."

For the reason, the Section 301(e) Study Group recommended the use of the common law concept of joint and several liability. To soften the potentially harsh effects of joint and several liability, the common law excepted those whose contribution to the injury was de minimus. This should be incorporated, as well as a specific provision that liable parties may seek contribution from other parties.

The Fund should be subrogated to all plaintiff's claims, whether based on present or past action. The Section 301(e) Study Group had recommended subrogation only for claims arising out of exposure after the date of enactment. This restriction is unworkable - for long latency diseases there may be no way of determining whether exposure occurred before or after the date enactment. In addition, for some time to come, most claims will arise from exposure occurring before the date of exposure, thus placing a severe drain on the Fund. Since the allocations to the Fund provided for in various bills are very modest, we doubt that this is good policy.

CONCLUSION

I want to thank you for the time you are taking to explore this important question. The issues are complicated and deserve in depth consideration and thoughtful discussion. They are resolvable, however. We urge that resolution occur in this Congress. I would be happy to answer questions.

TESTIMONY OF ANTHONY Z. ROISMAN

BEFORE THE SUBCOMMITTEE ON COMMERCE, TRANSPORTATION, AND TOURISM OF THE HOUSE COMMITTEE ON ENERGY AND COMMERCE, JUNE 28, 1983

Mr. Chairman and members of the Subcommittee, my name is Anthony Z. Roisman. I am presently an attorney in private practice and among my clients are many families who are the victims of exposure to toxic substances that originated from hazardous waste disposed of in a manner which at the time of the disposal was characterized as "current industry practice" or "state of the art technology." I was previously Chief of the Hazardous Waste Section of the Land and Natural Resources Division of the Department of Justice. I appear here today to support this Subcommittee's longstanding effort to provide some form of compensation for the victims of state of the art hazardous waste disposal technology.

In 1976, when Congress enacted the Resource Conservation and Recovery Act (RCRA), it found that "disposal of solid waste and hazardous waste in or on the land without careful planning and management can present a danger to human health and the environment," that "inadequate and environmentally unsound practices for the disposal or use of solid waste have created a greater amount of air and water pollution and other problems for the environment and for health" and that "hazardous waste presents ... special dangers to health." 42 U.S.C. 6901(b)(2)(3) & (5) (§ 1002(b)(2)(3) & (5) of RCRA). Among the evidence Congress gathered prior to enactment of RCRA was the shocking revelation that persons living near the Love Canal hazardous waste dump in Niagara Falls, New York had an abnormally high percentage of a variety of serious health effects and had been and were continuing to be exposed to significant levels of contamination from Love Canal.

By 1980 when Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund) there was broad acceptance of the fact that hazardous waste not only can but already had caused serious and widespread health problems. By that time Love Canal had become the focus of public awareness of the dangers of hazardous waste and Congress referenced the studies showing increased levels of miscarriage and birth defects among the Love Canal families.

Today, seven years after the Love Canal disaster became a matter of public knowledge, after enactment by Congress of two major pieces of legislation specifically addressing the hazardous waste problem and after it became obvious that Love Canal was not only a tragedy but the first signal of a nationwide health crisis, not a single victim of that tragedy has received any compensation for the health damages they suffered and continue to suffer. Nor have any other victims of hazardous waste been compensated for the damages they suffered -- not in Times Beach, Missouri; not in Dallas, Texas; not in Midland, Michigan; not in Jackson Township, New Jersey; not in Hardeman County, Tennessee. To those who may consider being uprooted from your home, placed in motels and trailer camps, fed at diners and fast-food restaurants and paid a sum of money for your family home which is inadequate to enable you to purchase a comparable home as compensation, let them offer to trade places with the victims who have been so "compensated."

It is a cruel irony that the victims whose suffering produced the groundswell of support for legislative programs have yet to benefit from this legislation. Enormous pressures from the chemical, hazardous waste and insurance industries persuaded Congress in 1980 to duck the victims compensation issue in order to enact at least the clean-up provisions of Superfund. The Section 301(e) study mandated by that law has been completed and its diverse membership endorses the need for victims compensation legislation. This is legislation which cannot be denied and which has already been too long in coming.

As this subcommittee continues its deliberations on this legislation, several key concepts will emerge as pivotal. Today I will address some of these concepts.

First, where should the legal presumptions lie under the compensation legislation? In this world of imperfect knowledge we will inevitably have to face points of decision where we cannot be certain we will be right -- but nonetheless a decision must be made. In no area is that concept more relevant than compensation for victims of exposure to toxic substances. Many distinguished scientists correctly note that our knowledge in this area is still limited and that it is often difficult if not impossible to prove to a scientific certainty that a particular illness was caused by a particular toxic substance which had its origin from a particular source. As I will discuss later, there are some exciting breakthroughs in this area which greatly expand our available knowledge, but for the moment let us accept the point put forward by these distinguished scientists. We still must answer the question what should society do in the face of this inadequate knowledge particularly when we do know as a matter of scientific certainty that some toxic substances do in fact cause some illnesses and that there are identifiable sources of such substances?

It is at this point, when society attempts to decide what action to take, that the controversy arises. Those who in some way have a connection with the production, use, disposal or insurance related to the toxic substances quite understandably argue that compensation to victims should not be allowed (at least not if they have to pay for it) until we know as a matter of scientific certainty that the substance caused the particular illness and had its origin from a particular source. These same interests make a similar argument against setting standards for pollution control and favor instead the continued exposure of persons to the polluting substances until the sheer weight of the body count establishes the scientific certainty which they demand. Congress has properly rejected this approach for establishing pollution control. It has realized that we cannot tolerate the use of the public as a guinea pig and thus hazardous waste and other environmental and health laws establish standards based upon avoidance of risk. The fundamental principle at work in these statutes is that while adherence to risk avoidance may unnecessarily control a pollutant or exclude a product the harm caused by occasional "over-regulation" is substantially less than the harm which would be caused if a highly dangerous pollutant or product were allowed to be widely distributed and the feared risk were realized. In short these laws place the presumptions in favor of human health over corporate profits.

Victims compensation laws should do the same. Once it is established that a person has a genuine illness which has been shown to be of the type caused by toxic substances the presumption should be that the person is a victim who is entitled to compensation. Once a particular source is identified at which the toxic substance was present, from which it escaped and that the victim was in an area which could be reasonably expected to be affected by the substance then the presumption should be that the source caused the victim's illness. If the source can establish that the illness was not caused by the substance or that it was not the source of the victim's exposure, then the source would not be liable. In short the burden of scientific certainty should be placed on the person best equipped -- financially and techologically -- to carry that burden. To place on the victim a burden of proof that the victim is financially incapable of meeting is to make a mockery out of the concepts of due process of law and equal justice under law.

This brings me to my second point. Obviously a potential victim must be able to prove something to be compensated by the system. How does this victim obtain that information? A properly taken and thoroughly analyzed well water sample will cost $1,000 to $3,000. Medical tests and diagnoses can add thousands more. A groundwater study to connect the local dump to the polluted well will run $25,000 and up, depending upon the complexity of the problem. Epidemiological studies to demonstrate that among those exposed to the toxic substances there is a statistically relevant increased level of the illness suffered by the victim will add $50,000 or more. Lawyers taking toxic tort cases are anticipating a minimum of $100,000 to $200,000 in costs just for gathering the scientific and medical information required to prove a claim.[1] Unless a victims compensation law addresses this problem, the law will be nothing more than a cruel joke -- offering compensation to the handful of very rich people who happen to be living near a hazardous waste dump. Even presumptions cannot solve this problem but there are at least two approaches which I believe warrant consideration:

1. Establish a very low threshhold standard for a victim to meet -- i.e. illness of the type caused by a particular toxic substance and a possible source of the

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[1] These costs would not have to be incurred for each individual, but rather for each affected area. Of course if 1,000 people over a large area were affected the costs would be higher but for several dozen families in a single neighborhood with a nearby dump site these costs should cover the factual development of their case.

toxic substance in the area -- and once the standard is met the victim will be entitled to fund compensated scientific and medical investigations. In any recovery by the victim the amount of these costs would be returned to the fund. In this example the compensation fund becomes a revolving source of financial aid.

2. When the same threshhold is met either require the suspected source to pay the cost of investigation or to conduct, under independent supervision, the necessary investigations. In this example we extend to victims compensation the same standards used by the federal government in enforcing § 7003 of RCRA (the imminent and substantial endangerment provision) or in exercising its authority under § 3013 of RCRA (ordering data gathering by the source based upon a possible substantial hazard).

These are not exhaustive, but illustrative. The principal point I want to make is that the victims must have access to the financial wherewithal to prove their point or they will be certainly shut out of the system.

My third point relates to the role of the state common law system in providing redress to victims. I am a great fan of the common law because I believe it embodies the fundamental principle upon which this democratic society is based -- justice. Unconstrained by statutory language and legislative history a court and/or jury deciding a case under the common law is basically asked to listen to the facts, decide where justice lies and render a judgment accordingly. Large corporations are not surprisingly frightened by this system because once the individual has the resources to prove his facts the corporate leverage of money, political influence and sheer power is gone and the two litigants are essentially treated as equals by the judge and jury. While I am not surprised that industry seeks to avoid this system of basic justice (such as urging Congress to adopt product liability or victims compensation legislation that will essentially eliminate the common law in that area), I feel it is important to realize what motivates that position.

At a conference on toxic torts two years ago, representatives of the chemical and hazardous waste industry urged adoption of a form of victims compensation legislation that would essentially replace common law with a statutory scheme and their principle emphasis, echoed by the insurance industry, was unless such a scheme existed there would be no economic certainty. In short, the industry wanted to know up front what its liability would be so that insurance premiums and product prices could be established accordingly. Not only does this approach turn human suffering into nothing more than a budget item and encourage cynical judgments to let a certain number of people die because the coproration "can afford it" but it unfairly shifts all the risk of uncertainty to the public which does not know who will be injured and how seriously and who will die. Surely before we start giving economic certainty to those who cause these problems we should provide certainty to the public about the nature and extent of the harm that will be caused.

Thus a victims' compensation scheme should preserve state and federal common law to allow for recovery, where appropriate, beyond that provided by the compensation fund. The formula recommended by the § 301(e) Study Group is one which I feel would accomplish this result.

Should some of the liberalized standards and presumptions available under a victims' compensation program be included as new standards under common law? I am inclined to think not if the system will provide victims with the resources necessary to gather the relevant facts. Emerging doctrines of common law are, in some jurisdictions, beginning to recognize that scientific certainty is not a pre-requisite to recovery. New scientific techniques such as the work of research immunologists like Dr. Alan Levin of San Francisco conclusively establishing the presence of chemically induced immune system damage in blood samples of victims are making it possible for victims to meet their evidentiary burdens if they have the resources to make their case. However, if the resources to prove the case are not available, then the common law principles must be modified to shift the burdens in order to preserve the opportunity for justice.

Finally, I do favor the principle that the federal law should clearly provide the opportunity to bring a toxic tort in federal court as a federal common law right of action. The potential for uniformity of development of common law principles and the stature of the federal judicial involvement in these issues is vital. It would be anamolous were Congress to properly recognize hazardous waste victims as a class deserving federal attention but deny them access to federal courts to redress wrongs not fully compensated by the fund.

Thank you for the opportunity to appear once again before the Subcommittee. I will be pleased to answer any questions you may have.

EXCERPTS FROM

U.S. Congress. Senate. Committee on Environment and Public Works. Subcommittees on Environmental Pollution and Resource Protection. Hazardous and Toxic Waste Disposal, Part 4. Joint Hearings, 96th Congress, 1st session. Washington, U.S. Government Printing Office, 1979. 854 p.

RESPONSES BY THOMAS C. JORLING

Assistant Administrator for Water and Waste Management, U.S. Environmental Protection Agency, to written questions from the Subcommittees.

Question: What options exist, other than changing the fee structure, for inducing higher standards of care in the hazardous substances and wastes area, especially through prevention and deterence?

Answer: It should be noted that with regard to uncontrolled sites, the goal of achieving higher standards of care is not relevant because it is already too late, emergency assistance and containment are required. However, there are two options which could improve prevention and deterence of other hazardous problems.

- Under the uncontrolled sites portion of the Administration bill, liability for hazardous wastes at sites includes the generators of such wastes. A similar liability provision could be built into the hazardous substances spill portion of the proposal. By making producers, as well as the party which spills, liable for damages from a spill, an additional party--the producers--would have a strong incentive to improve standards of care throughout the chain of commerce.

- Extending the financial responsibility requirements of the bill to all potentially liable parties might also increase standards of care. While not much is known about this area, we do know that certain types of concerns, such as small trucking firms, would have trouble meeting limits of liability if financial responsibility insurance were sought on an individual, firm-by-firm basis. Thus the bill would have to assist in the formulation of insurance pools if the requirement were to be meaningful. Doing so would bring the insurance industry more broadly into the picture and utilize their interests to induce higher standards of care.

Question:	Why doesn't the Administration Bill provide for a Federal cause of action? Is this issue being studied?
Answer:	Inclusion of a Federal cause of action was considered and rejected during interagency review. The primary reasons the Administration did not create a Federal cause of action for damaged third parties (especially for medical costs) were:

(1) Such a provision would of necessity pre-empt State tort law. In order to respond quickly to the abandoned sites problem, the Administration could not adequately determine the concepts on which the various States have developed their tort law and propose a clearly superior approach. Instead, the Administration bill refrains from any preemption of State authority to raise funds to compensate victims or modify existing State tort law. Therefore, the States may act to provide improved access to the courts or a State run compensation program.

(2) Any Federal cause of action would have to cover all third party damages, otherwise injured parties (and defendants) may have to bear the delay and costs of two trials--one in State courts and the other in Federal courts. In some States, plaintiffs would be prohibited by State law from pursuing both avenues of relief.

(3) The Federal court system and the case load handled by the Department of Justice is already overwhelming the Federal judicial system. A Federal cause of action for third parties would further tax this already stressed system and it is not clear that more expeditious settlements would result.

(4) It is the Administration's position that any decision regarding compensation for personal injury should be made in the context of government-wide policy on health care and not in the superfund context.

In response to a question on June, 1979 during hearings held by the Senate Committee on Environment and Public Works, Tom Jorling, Assistant Administrator at the EPA, stated that a Federal cause of action was being studied further. This response to the question was in error. With respect to superfund, further study of a Federal cause of action is not underway within the Administration at this time.

Question: Project the estimated costs to the Superfund if it were expanded to cover out-of-pocket medical expenses.

Answer: As was stated at the hearing, virtually no data exists on the out of pocket medical expenses of individuals affected by toxic wastes from abandoned sites. Nor does any data exist about the number of sites which have actually caused human health problems as opposed to those which might potentially do so. Finally, no data exists concerning the number of people per site who might be affected. For these reasons, the analysis which follows must be viewed as a set of estimates and projections which have virtually no basis in reality. Notwithstanding, these estimates and projections can at least serve an illustrative purpose of indicating what resources the superfund would need if these figures were, in fact, real.

As far as average out of pocket costs are concerned, information developed by the Labor Department from analyzing Social Security disability roles indicates that for people who are unable to work--which may be a reasonable substitute for people affected by toxic wastes--average medical costs over a five year period are in the range of $8000. On an annual basis this comes to $1600.

As far as the number of sites is concerned, of the 2000 sites considered potential threats, we must simply make a guess that one-quarter, or 500, will have actual human health impacts. Another guess is that the average number of people affected per site will be 100. This would mean somewhere in the neighborhood of 50,000 people would receive out-of-pocket medical expense compensation each year. The annual cost to the fund, using these figures, would be $80 million ($1600x500x100).

Three critical points must be made about these figures. First, as cannot be emphasized enough, they are simply guesses and could be inaccurate by orders of magnitude. If, for example, there are significant health problems at 1000 sites and the average number of people affected per site is 200, then even using the same $1600 per person estimate we have an annual cost figure of $320 million.

Second, these figures do not include any catastrophic situations such as the poisoning of a drinking water supply system for 25,000 people. If only one of these occurs each year for 5 years, and the average out-of-pocket costs per person are $1,000, the total cost would be $125 million. At Love Canal, for example, more than $1 billion in health claims have been filed. At the James River Kepone site, approximately $64 million in personal injury claims have been filed.

Third, these figures do not include any out of pocket medical expenses for the additional 30-50,000 sites which the Hart report suggests may contain hazardous wastes. If we say that only 5%, or 1500, of the lower 30,000 figure have health problems associated with them, that an average of 100 people per site experience such problems, and the average annual cost is $1000 per person, then the total annual cost above the $80 million reached earlier would be $150 million.

For all of these reasons, but especially the first, the Administration does not believe that out of pocket medical expenses should be covered by superfund. As the first caveat indicates, we really haven't any realistic means for projecting what costs would be. Therefore the Administration suggests that medical costs associated with hazardous waste sites be considered in the context of National Health Insurance and not superfund.

THE TOZZI (OMB) MEMORANDUM OF APRIL 18, 1983: THE OTHER SHOE

Excerpts from the Memorandum
to the Ad Hoc Group on
Toxic Torts [U.S. Government]
from James J. Tozzi of OMB

"EVALUATING THE MERITS OF ALTERNATIVE LEGISLATIVE PROPOSALS ON TOXIC TORTS: STATUS REPORT

"The Ad Hoc Group on Toxic Torts was created in reaction to the existing legislative proposals to modify State tort liability law, to create a fund similar to Superfund financed through industry taxes and to adopt limited administrative no-fault compensation, modeled on worker's compensation laws. This group is to identify the scope of the

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existing and foreseeable effects of exposure to hazardous substances, to describe economic and other aspects of each existing recompense system, and to compare the effects and implications of adopting each legislative proposal and to help the Administration determine if any change is needed, and, if so, which proposal is better.

"Basic Policy Issues

"How serious is the problem with human exposure to hazardous substances? Taken as a whole, are existing recompense systems inadequate? If so, what is the most cost effective and administratively straightforward way to fix this?

"The March 4 Meeting

"To help focus the work of this Ad Hoc Group, OMB prepared and distributed draft Work and Study Plans. The Ad Hoc Group then met on March 4 to discuss these. Present were representatives from CEA, Commerce, DOD, EPA, Justice, Labor, NASA and OMB. . . .

. . . .

"Data Collected to Date

"After the March 4 meeting, agencies provided us with copies of various studies and reports. We received material from USDA, EPA, Justice, Labor, and the National Institute of Environmental Health Sciences. . . .

"1) Exposure and Causation.

> "One of the key problems faced by the Ad Hoc Group is to evaluate exposure to toxic substances and to what extent such exposure has caused adverse human health effects. . . .
>
> "Two studies provided summary data on the number of cancer deaths and the extent to which these deaths are related to certain exposure factors. The Office of Science and Technology Assessment (OTA) reports that there were approximately 400,000 cancer deaths in the United States in 1978.

Of these deaths, less than five percent are related to pollution. The second report estimates a slightly higher rate of seven percent when cancer deaths due to three factors--occupation, pollution and industrial products--are grouped together. The majority of this seven percent estimate is due to occupational factors.

"It appears that exposure to toxic substances has not substantially affected cancer mortality rates, and that other factors have a much greater effect. For example, "the only cause whose effects are both large and reliably known is tobacco," which is directly related to 25 to 40 percent of cancer deaths.

"Another factor associated with a large proportion of cancer deaths is diet. Doll and Peto report a range of 10 to 70 percent of cancer deaths related to dietary habits. The OTA reports a narrower but consistent range of 35 to 50 percent and adds that "Dietary components such as high-fat and low-fiber content, and nutritional habits are believed more important than additives and contaminants," which would indicate that chemical exposure through the food chain does not substantially increase the risk of cancer.

"Data on the effects of occupational exposure to asbestos vary. OTA reports a range of 3 to 18 percent for cancer mortality due to asbestos exposure in the workplace. Doll and Peto report total occupational related cancer deaths in a range of 2 to 8 percent.

"Other information submitted by the agencies provides sketchy evidence that cancer mortality is not the only adverse effect resulting from exposure to toxic substances. An EPA report indicates that human health constituted eight percent of the affected areas damaged by hazardous waste mismanagement. However, the data do not indicate the type or extent of the effects. . . .

. . . .

"This review would be not complete without mentioning the analytical difficulties encountered when trying to prove that exposure has caused an adverse effect. Laboratory tests on animals, which do not depend on humans illness or death to produce data, have been developed to study effects of exposure to chemical substances. Tomatis, however, is cautiously aware of the "fallacy of considering that carcinogenicity data in experimental animals automatically indicate a danger to humans." Epidemiologic studies on humans are also limited. "Cancers typically appear years or decades after exposure . . . people move from place to place, change their type of work, change their habits and it is hard to locate them and to estimate their past exposures to suspect agents." The Hazardous Waste Mismanagement Damage Case Histories summary mentions several state conducted epidemiologic studies and discusses possible study limitations.

"There are over 58,000 chemicals and substances in existence. However, only 18 chemicals and industrial processes are proven to be carcinogenic for humans. A further 18 chemicals and groups of chemicals are considered to be probably carcinogenic for humans, although the data are inadequate to establish a causal association.

"2) Existing Recompense Systems.

"We appreciate the material we have received and anticipate that more will be developed as the Ad Hoc Group continues this work. In the meanwhile, we are analyzing what we have received and will make it available after the analyses are complete.

"The Scope of the Problem

"To summarize, we can estimate that seven percent of cancer deaths are related to exposure to pollution. Causation is difficult to prove and other factors, such as cigarette smoking and dietary habits, have a much greater effect on cancer mortality. One study summarizes existing cancer data with a statement that "examination of the trends in American mortality from cancer over the last decade provides no reason to suppose that any major new hazards were introduced in the preceding decades other than the well-recognized hazard of cigarette smoking." Data on other effects are limited. One individual has found no adverse effects on a very high exposure population.

"Given the information made available to us to date, we conclude that to protect the public health, the Federal Government could make the most efficient use of the nation's resources by focusing new programs on decreasing the use of tobacco and encouraging improved dietary habits."

Statement of
Courtney Riordan
Acting Assistant Administrator for
Research and Development
U.S. Environmental Protection Agency
Before the
Subcommittee on Investigations and Oversight
Committee on Public Works and Transportation
U.S. House of Representatives

July 21, 1983

Good morning, Mr. Chairman and members of the Subcommittee. I am Courtney Riordan, Acting Assistant Administrator for Research and Development of the U.S. Environmental Protection Agency. I welcome the opportunity to appear before you today to discuss scientific and health research issues which relate to the problem of toxic victim compensation as well as EPA's current research work.

On June 29, 1983, Jim Barnes, Acting General Counsel of EPA, appeared before Chairman Florio's Energy and Commerce Subcommittee on Commerce, Transportation and Tourism to discuss the general issue of toxic victim compensation. In his statement, Mr. Barnes indicated EPA's and the Administration's concern for those exposed to or living in areas subject to the potential risks due to hazardous substances and outlined our efforts to address this critical issue. Additionally, he discussed a number of concerns we have regarding various proposals in this area—including concerns relating to science and health issues. I respectfully submit to you a copy of Mr. Barnes' statement and request that it appear as part of the record of today's hearing.

I share Mr. Barnes' concerns over the plight of those exposed to hazardous substances as well as those who live in areas faced with potential hazard. I feel that it is important that we in government--at all levels--do what we can to inform and, if necessary, assist those faced with the likely or potential effects of toxic exposure due to improper use, release, or disposal of hazardous substances.

A critical part of any attempt to consider this multi-faceted problem is to understand the current state of scientific knowledge and efforts to obtain adequate scientific data and appropriate methods for useful analysis. I should note at the outset that EPA is but one government agency involved in this area. For example, EPA's "Superfund" statute assigns to the newly created Agency for Toxic Substances and Disease Registry responsibility for health monitoring and health assessments. EPA is also working closely with States, and in particular State Health Departments, on these matters.

In my statement, I will first discuss EPA's risk assessment activities under our existing statutory mandates. Second, I will address a number of the key scientific issues which must be considered when examining the various proposed compensation schemes, including: exposure, likelihood of injury, and causation. Finally, I will outline the research efforts currently underway involving EPA which may offer some assistance in this area.

Risk Assessment in EPA

Within the federal government, EPA's risk assessment responsibilities are unusual in that they emphasize assessments of health risks for regulatory decision making. The manner in which risk assessments are used depends upon the statutory provision being implemented. By contrast, the National Institutes of Health, for example, and within it, the National Institute of Environmental Health Sciences, places a much greater emphasis on basic research. These entities do not have regulatory responsibilities. Although the EPA conducts research and risk assessment in many health areas, our cancer risk assessment approach provides insight into the complexities and limitations of performing risk assessment generally.

In assessing the possible risk of carcinogens posed by individual chemical substances, EPA follows a two step approach. Risk assessment attempts to answer two questions: 1) how likely is the event to occur? 2) on the assumption that the event does occur, what is the magnitude of the public health impact? Since only rarely do we know for sure that an agent is indeed a human carcinogen, the first step involves an evaluation of all the biomedical data to determine the weight-of-evidence that an agent might be a human carcinogen. The second step involves the quantification of risk, that is public health impacts, in terms of rough estimates for current exposures as well as estimated exposures for various regulatory options.

To answer the first question regarding likely carcinogenicity, EPA weighs the biomedical evidence as ranging from the strongest evidence based on human data, backed up by animal bioassay tests; to suggestive or supportive evidence provided by positive results from short-term in vitro test. This weight-of-evidence is described in terms of the nature of the responses, the quality of the data, and an evaluation of both positive and negative results.

The second step, that of presenting some quantitative estimates of public health impacts, is presented in terms of rough estimates describing the individual increased cancer risk for exposed sub-population groups, (i.e., increased risk of, for example, one chance in a thousand or $1x10^{-3}$) and the nationwide impact in terms of annual increased cancer cases. This second step is intended to give the regulators a feel for the potency of the suspect carcinogen and some rough idea of the magnitude of the public health problem. It seems useful to provide these rough estimates as a measure of potency, because the potency of carcinogens can span a range of fifty million fold. There is an obvious desire to take this disparity into account in making public policy decisions even though scientific methods for precisely describing quantitative risk associated with environmental exposure was and still is a very underdeveloped field. For most suspected carcinogens, there are no methods currently available to accurately describe risk outside the dose range where effects have been bracketed between a plausible upper bound and a lower bound approaching zero. The upper bound is calculated using conservative exposure estimates and the linear, non-threshold dose response model at low doses.

In many ways the approach has worked reasonably well. The qualitative (i.e., biomedical) evidence coupled with quantitative, rough estimates are useful in setting priorities; and balancing risks against benefits, and in considering residual risk after the application of best available technology.

Risk assessment approaches have evolved over the years and will continue to do so. This is a rapidly developing field but there are large gaps in scientific knowledge which must be filled in order to make real improvements in risk assessment methodology.

In short, the utility of risk assessment has been demonstrated in the EPA, but there are many scientific uncertainties associated with risk assessments. Our experience is helping to shape our current research efforts. These efforts are only able to give us crude indicators of potential adverse effects and the extent of harm within a population. They do not pinpoint in any specific manner whether ill effects will occur and, if so, in which exposed persons, nor do they allow for an increase expected by chance alone in a population based sample.

Present risk assessment activities at the EPA, in response to our statutory mandates, have centered upon analysis of single chemicals. The difficulties there are less than they are for chemical mixtures, such as diesel emissions. When we come to hazardous waste sites, we will have multiple problems in performing and in interpreting our risk assessments. There are potentially thousands of waste sites nationwide, each containing literally hundreds of different chemicals. We must determine which chemicals are present, in what concentration, and we must estimate the proportion of chemicals that humans are exposed to and what proportion may enter the body. Existing hazard data on each of the chemicals must be assembled and analyzed to determine if there may be a problem. Exposure and hazard information need to be combined to estimate in some quantitative manner our degree of concern about potential risks. To deal with 400 or more chemicals per site becomes a difficult task, and we really have no means presently of intelligently evaluating possible interactions, for example, synergism among chemicals. Each toxic waste site is a unique microcosm of potentially hundreds of chemicals and spontaneous reaction products. To help illustrate some of the pitfalls in performing assessments at waste sites, let me give some examples.

Love Canal, New York is especially illustrative of the great number of varied substances which might be involved in one site. For Love Canal, not only do we still have some incompletely described compounds but even those for which we have described health information, the data are limited. Well over 400 organic substances were found to be present.

Exposure Information Available to the Agency

Environmental exposure to hazardous substances outside of the workplace is generally quite low but may be persistent through time. Depending upon where and when environmental sampling is conducted, exposure estimates of varying accuracy may occur. For example, measurements of PCB's, dioxins, or metals in the immediate area around dumpsites may be representative of levels which can be used to determine exposure. However, the same may not always be said for volatile organics. Here the transport through the dumpsite and neighboring areas as well as through man may be quite rapid. Thus, in the case of volatile organics, even if a health effect were the result, documenting and quantifying the exposure which may have contributed to this outcome may be difficult if not impossible.

Body burden will be dependent upon more than isolated environmental measurements. It must also take into account specific routes of exposure and habits of certain population subgroups. For example, a child who eats soil might have much higher levels of certain toxic substances than an adult under seemingly the same exposure conditions.

Likelihood of Injury

It is difficult to determine whether exposure to a hazardous substance has caused a particular adverse effect. Of the 400 plus compounds found in Love Canal following analysis, 10.8% were tentatively classified as mutagens, 12.8% as carcinogens, 7.2% as fetotoxic, 15.8% as neurotoxic, 9.7% as hepatoxic, 9.5% as renal toxicants, and 8.6% as pulmonary toxicants from animal and in vitro tests. Little or nothing was known about the potential toxic effects of the remaining substances--over half of those found.

Levels of exposure will generally be quite low when compared to animal or even industrial exposure settings. It appears that most health effects resulting from hazardous substance exposure are likely to be chronic effects involving commonly occurring diseases, rather than rare diseases. Thus, it will be necessary to separate increases in various relatively common outcomes from the expected rate. Low birth weight and chronic lung disease, for example, rather than mesotheliomas which can more confidently be associated with a certain exposure to a specific chemical agent.

In order to get an idea of what this means on a site specific basis, we should consider the relevant experiences at Love Canal and Woburn, Massachusetts.

The only study on Love Canal which so far seems to have demonstrated a statistically significant difference between exposed and comparison groups related to birth weight. Low birth weight is strongly associated with major malformations, high neonatal mortality, and developmental problems. In the surrounding "swale" area a highly significant increase in the rate of low birth weight was seen even after correcting for many maternal risk factors, including maternal alcohol consumption, maternal cigarette consumption, and other maternal characteristics. This result is also consistent with the literature on animal embryo toxicity with lower dose chemical and pesticide exposure. However, low birth weight is expected to occur in roughly 6% of the white and 12% of the black births. In addition, a base line expected low birth weight rate that takes maternal risk factors into consideration, is difficult to establish.

In general, the Love Canal experience is valuable in considering victim compensation issues as it emphasized several important points, including the following.

1. Looking for rare health outcomes probably will not be helpful except in specific circumstances, such as with sufficiently large population groups to be able to detect the event.
2. Looking for an increase in chronic health effects which requires an understanding of the expected rate for a similar unexposed population is much more likely to be fruitful.
3. Exposure types and amounts especially for volatile substances will change through time and will be difficult to document.

Finally, I would also like to offer some comments on Woburn, Massachusetts, a place where a cluster of adverse health outcomes has been seen and evaluated in terms of associated environmental pollutants. This area has also been cited in support of legislation for toxic victim compensation.

In the summer of 1979, the citizens of Woburn, which is located about 12 miles northwest of Boston, became quite concerned over the health impact of 100 years of dumping various arsenic and other compounds in the Northeast sector. The initial concern arose when an apparent increase in childhood leukemias was discovered. In eastern Woburn over the period 1969-1978 a 12-fold increase over the expected rate was seen in childhood male leukemias.

Historically the area of exposure was a leading producer of arsenic compounds from 1900-1915 as well as other chemicals and glues. The main route of suggested exposure was through two particular wells supplying drinking water throughout the 1950's through the 1970's. Unfortunately, historical information on drinking water toxic substance content was lacking. The problem was evaluated by the Commonwealth of Massachusetts and the Centers for Disease Control and the following conclusions were drawn. Although there was an increase in leukemias around the Woburn area, case-control questionnaire data failed to identify any lifestyle differences among the cases and controls. For the one compound known to have heavily contaminated the area, arsenic, previous human epidemiologic studies have shown increased rates of lung and skin cancer following arsenic exposure but not leukemia. In other words, investigators were unable to discern whether any of the potential chemical exposures could account for the clustering of leukemia cases.

Causation

The above discussion helps to indicate that determining a cause of an observed health effect is a very difficult problem--one with which science is currently struggling. This is especialy the case with chronic effects, which are the types we most expect to occur from exposure to hazardous waste sites. Our risk assessments can only give us some rough indications of how much levels of exposure may increase the chance of injury. Applying these kinds of test results to the compensation setting is problematic. In chronic exposure cases, we are usually confined scientifically to determining association of exposure and disease, not causation. Furthermore, we cannot confidently distinguish between individuals in the background population who would develop illness anyway and those whose illness is attributable to hazardous substance exposure.

Problems continue to affect our ability to predict health effects in humans. The scientific community involved in risk assessment is aware of these problems and is continually seeking to improve the state-of-the-art of risk assessment. To summarize, we have a long list of waste sites. Each contains a myriad of hazardous substances that must be identified and quantitated. Not only is our information on health effects limited for many of these substances, but our testing procedures cannot account for multiple risks, synergistic, or antagonistic reactions among chemicals. Second, although a substance may clearly injure both animals and humans, the manifestations of illness may be quite different in humans than in animals. This problem makes human health effects difficult to predict. Third, many chronic health effects occur after years of low-level exposure. Modeling this would be very time-consuming and expensive, so instead we test in a shorter period using large doses. This procedure yields sound information for regulatory purposes, but whether the conclusions are appropriate to decisions that would have to be made in a compensation system is not clear and is, fundamentally, a policy decision.

Related Research Efforts

Some of the efforts now underway at EPA which may be of future help to prioritize and evaluate hazardous substance risk include the following.

1. Establishing the expected rates for sensitive reproductive health outcomes in children at the county level.
    - A. County level: As mentioned before, birth weight is a sensitive indicator of toxic substance effect on animals and as suggested in Love Canal may be a good outcome to assess for humans. We are presently developing national county level birth weight mapping techniques using vital statistics records which adjust for maternal risk factors using specific statistical techniques.
    - B. Local Level: EPA in collaboration with New York State and now with Missouri will be developing a local census tract level assessment of birth weight using similar techniques to those developed at the national levels. In addition, adjusted childhood cancer rates are also being added at the local level. It is hoped that besides a comparison to national mapping techniques, more and better risk factors can be considered to refine the assessment technique and aid in priority setting for dumpsite clean up. Potentially the techniques being developed in these two states could go down to the level of Love Canal areas. This is also being developed to complement ongoing state efforts in this area.
2. Animal/Human Correlation Studies: The currently available animal toxicity information on reproductive problems associated with toxics substance exposure is being compared to all available human data on the same substances to begin to address the problem of generalizing animal study information to human risk assessment.

3. Correlation of exposure induced genetic damage in somatic (body) and germinal (reproductive) cells resulting in heritable changes which might involve risk to future generations of exposed individuals.

4. Significant gaps in the risk assessment methodologies are being addressed along with validation of methodologies. Although past efforts have been essentially limited to cancer risk, we are currently working on both qualitative and quantitative procedures to improve risk extrapolation methods for animals to man for mutagens and carcinogenesis, as well as for potential adverse specific health effects such as: neurobehavioral, pulmonary, hepatic, reproductive, and teratologic. Methodologies to predict heritable genetic effects of chemicals found in the environment will also be addressed.

5. ORD is now verifying a screening test system to evaluate the potential health effects of complex waste mixtures. The proposed program uses in vivo and in vitro assays of increasing complexity to estimate the biological activity of the complex mixture.

Conclusion

Adequate consideration of the full range of toxic victim compensation issues will require coordination, cooperation, and good will within EPA, the Executive Branch, and between the Congress and the Administration as well as with the States. Everyone will be affected by what is finally decided here in Washington, whether they be from business or from affected or potentially affected areas.

We all feel a deep concern for the victims and potential victims of hazardous substance exposure. We at EPA pledge to do what we can to assist in this important effort and will keep this Subcommittee and Congress apprised of our activities as well as progress toward the goal of developing more scientific certainty in the area of health effects resulting from exposure to hazardous substances.

It must be understood that science can only provide statistical probability of cause. Given that limitation, it must be left to the policy maker, not the scientist, to decide whether to award compensation.

This concludes my prepared statement. I would be happy to respond to your questions.

Statement of
A. James Barnes
Acting General Counsel
U.S. Environmental Protection Agency
Before the
Subcommittee on Commerce, Transportation, and Tourism
Committee on Energy and Commerce
U.S. House of Representatives

June 29, 1983

Good morning Mr. Chairman and members of the Subcommittee. I am Jim Barnes, Acting General Counsel of the U.S. Environmental Protection Agency. I welcome the opportunity to appear before you today to discuss toxic victim compensation and the proposals aimed at addressing it.

The issue of victim compensation goes well beyond EPA in terms of impact and meaning, as it also relates to a multitude of issues, including health-related costs and income maintenance. In recognition of this, and to coordinate Administration efforts and to develop an Administration position, the President has designated a high level Cabinet Council Working Group, under the auspices of the Cabinet Council on Legal Policy. One of the major functions of this Working Group is to review the legislative proposals in the victim compensation area as they relate to existing tort law and existing compensation schemes, such as Black Lung and Social Security. As part of this effort, EPA is working closely with other Federal agencies to consider issues with government-wide implications. This effort will require some time; however, it is driven by the realization on all our parts of the urgent nature of the possibly unfilled needs of those affected by toxic exposure.

Those who suffer debilitating disease from hazardous substance exposure obviously face serious physical, financial and emotional difficulties. We at EPA, and especially those who work to clean up high priority Superfund sites, are familiar with the ways hazardous substances can contaminate our environment by affecting the water we drink, the air we breathe, and the homes we live in. Of additional special concern are the anxieties and fears concerning possible health effects caused by exposure to hazardous substances. At EPA, we believe it is extremely important to provide accurate environmental and health risk information to the residents of areas where exposure to hazardous substances may have occurred. Indeed, openness about what we know, what we suspect, and what we do not know regarding the risks of injury and disease in these situations is perhaps the most important single factor in assisting individuals to cope effectively with the exposure. Ironically, it is this very area of the relationship between exposure and injury where we have the most uncertainty, and it is this uncertainty that is the major cause of frustration when the victims attempt to obtain compensation for their injuries.

Early Legislative Consideration of Victim Compensation

In 1980, the Congress considered including provisions for compensation for personal injuries in the Comprehensive

Environmental Response, Compensation, and Liability Act of 1980, also known as the "Superfund." It was decided, however, that the initial legislation would involve a Fund to pay the costs of cleaning up releases of hazardous substances and to compensate claims arising from damage to natural resources. Nevertheless, the sponsors of Superfund agreed that there was a need for more information regarding injuries to persons from exposure to hazardous waste. Thus, in order to provide some of the data and studies that would be needed for future consideration of personal injury-related issues, the Superfund legislation required that, under Section 301(e), a study be conducted of the adequacy of the legal remedies relating to injuries and damages from hazardous wastes. The results of that study have been available for approximately one year and form the basis for a number of legislative proposals currently being considered.

While the analysis of the legal issues has been extensive, I feel that there are other issues which are equally, if not more complex, and require equally thoughtful attention and analysis. All of the victim compensation proposals which are being considered rely heavily on an administrative compensation system to relieve the inadequacies and cumbersomeness of the judicial system. However, we must carefully consider the need for and the feasibility of the administrative schemes and whether the scientific knowledge necessary to implement them is available.

General Summary of Major Victim Compensation Proposals

The purpose of all these proposals is to improve the chances for recovery for injuries resulting from exposure to hazardous substances. All the bills provide compensation for personal injury resulting from exposure to a range of hazardous substances. Some bills also allow compensation for economic loss or natural resource damage.

All of the bills set up an administrative compensation program to handle victims' claims with payments from a fund. Some rely on extension and/or expansion of the Hazardous Substance Response Trust Fund established under CERCLA while others would create a Toxic Victim Compensation Fund through loans from the Hazardous Substance Response Trust Fund and transfers from the U.S. Treasury, when required. Money for the Fund may be obtained through recoveries from liable parties. H.R. 2582 sets up a separate Victim Compensation Fund with essentially the same tax base and the same tax rate as the Hazardous Substance Response Trust Fund. Most of the bills allow either judicial action or administrative claims, or both, as a forum for relief. Most of the bills would drastically reduce the burden of proof on claimants to establish their injury and its cause. In general, they would require three major findings to establish presumption of injury: (1) that there was a release of a hazardous substance(s) and that the claimant was exposed; (2) that the claimant was exposed for a duration and at a level that is reasonably likely to cause or contribute to claimant's injury; and (3) that it is reasonably likely that such exposure caused or significantly contributed to the type of injury alleged.

There are two types of scientific analyses that responsible agencies may have to prepare. One type is incident specific investigations to evaluate individual claims. The second type of scientific analysis requires assessments of the health impacts of specific hazardous substances, levels of exposure that would result in specific injuries, and associated levels of risk. As such assessments are completed they would serve as a basis for determinations in claims.

Issues Raised by the Proposals

We are carefully reviewing the victim compensation proposals introduced in this Congress. While EPA is not ready to take a position today, I would like to comment on some general issues that we believe we all need to address with respect to various victim compensation proposals.

At the outset, I should note that compensation programs such as the ones proposed by these bills involve many issues other than environmental considerations. We need to determine how such schemes will affect existing systems of compensation, particularly tort litigation. It has been suggested, for example, that the presumptions and evidentiary standards that may be part of a compensation system will eventually be incorporated in our tort litigation system; we obviously must consider the full implications of such a development. We also will have to consider the long-term fiscal implications of compensation programs. Experience with many government administered compensation programs has been that they have grown far beyond initial expectations; we must consider what we realistically can anticipate in terms of growth, both as to claimants and overall cost. We must carefully consider the administrative mechanisms for awarding compensation, and whether these mechanisms actually accomplish the ends sought, and at what costs. In evaluating the costs of compensation systems, we must consider the role of the legal profession and the portion of the compensation that would go toward payment of legal fees. We must also look at the economic consequences of compensation programs, and at who will bear the ultimate costs. And, we must consider how any compensation program relates to other compensation programs already provided by the Federal and State governments, including Social Security disability insurance, medicare/medicaid, and other forms of income maintenance.

These are all issues which go well beyond this Agency's mandate of environmental protection, and necessarily involve other Federal agencies and other Federal programs. In this regard, I would note that the Federal government has considerable experience with compensation programs, including the Black Lung miner's compensation program, Social Security disability insurance, and the Federal employee's and the longshoremans' compensation systems. There are valuable lessons that have been learned with regard to compensating individuals for injuries and illnesses, and we must look carefully at our experiences with these programs in determining whether a particular compensation program is warranted, and, where it is, how it should be structured.

The considerations I have identified above are but a few of the larger policy issues that will have to be dealt with in reviewing compensation proposals. These issues, and the many others we will have to consider, cut across the responsibilities and expertise of many Federal agencies and many Federal programs. As noted in the recent editorial in the Washington Post of this past Saturday, the issue of creating a compensation system involves much more than just determining the best environmental policy, and must be considered in this broader context. For this reason, the Administration has created the high-level interagency Working Group, referred to earlier in my testimony, that will review the broader implications of compensation systems, and the basic questions of social equity at issue.

I also wish to touch on four additional general issues that are particularly important to EPA: first, the scope and definition of the problem; second, the scientific and administrative issues which we must come to terms with in any victim compensation scheme; third, the potential impacts on EPA programs; and finally, the implications of the various funding mechanisms.

A basic question which many people raise with regard to toxic victim compensation is: what is the extent of the victim compensation problem? How many people are injured, what injuries do they suffer, and what and how many substances cause those injuries? Currently, the Agency is assessing the data we have to contribute to answering these questions.

In further viewing this issue, the complexity of defining the problem and its scope must be considered.

Toxic victim compensation has been most broadly defined to cover any injury or disease or death caused by any exposure anytime to any substance any place. On the other hand, it has also been limited to compensation for the injury, disease or death of any person due to exposure to hazardous waste not occurring in a workplace.

A number of questions arise in exploring the definition of toxic victim compensation; to follow are but a few of the most critical. For example, do we agree that only non-workplace exposures are intended to be covered, or would there be instances where occupational exposures should be included? Does "exposure" cover exposure only to hazardous wastes or does it extend to any release of a hazardous substance? Does "hazardous substance" cover only those substances traditionally found in waste sites, or does it extend to the broad range of substances (including those regulated under other laws) in the air, water, drinking water, and consumer use? What more need we know about possible multiple causes of some conditions that may be linked to exposure to toxic substances? What harms (i.e., death, injury, illness) are to be covered or compensated as a "toxic tort"? Should the proposals only address chronic, but not acute, health effects? What is the relationship of this type of action to product liability law?

The scientific assumptions and requirements which underlie all the victim compensation proposals are among the most important issues in the whole victim compensation area. All victim compensation proposals assume some ability through science to establish a cause and effect relationship between particular substances, exposure levels, and diseases. This may not be the case. We must look closely at the questions we are asking scientists in these proposals, to assess whether or not the ability to implement the legislative scheme exists.

In addition, although EPA has extensive experience regulating toxic chemicals under RCRA, FIFRA, TSCA, the Clean Air Act and Clean Water Act, the case specific scientific analyses and conclusions required in the proposed legislation differ significantly from our experiences with existing laws. The scientific data and analyses that would be required to answer the questions above may not currently exist. We intend to assess the ability of the Agency to gather such data and answer these questions. We must assess the scientific feasibility of implementing these potentially broad statutory requirements. Some of the proposals, including H.R. 2582, require the Federal agency, either EPA or HHS, to produce toxic substance documents. We are attempting to assess the magnitude of these requirements, but based on EPA's experience, these documents could be very costly and each one could take up to several years to complete.

A third area of concern for EPA is the possible impact of victim compensation proposals on existing programs and what the possible effect might be on our ability to carry out current responsibilities. Assigning a regulatory agency such as EPA responsibility to compensate people for injuries due to environmental exposure to hazardous substances might well create serious conflicts with EPA's existing responsibilities to regulate environmental contamination under the many statutes the Agency administers and to respond to hazardous substance releases under Superfund. Furthermore, EPA is not involved in administering any programs of this nature and therefore, all its administrative implications would require further analysis. Other agencies with expertise in this area might be able to provide valuable information to the Congress.

Implementation of Superfund is exemplary of this issue. Victim compensation claims and Superfund response actions could exert significant influence on each other. In making decisions related to taking response actions, the Agency gathers extensive data about a site and determines the most cost-effective response that mitigates any public health or environmental hazard. The data required to make these determinations may be very different from data the Agency would collect to assess victim compensation claims. Similarly, the Agency might decide that the appropriate response would be site closure and permanent relocation of residents without extensive cleanup or study of the area. Detailed health assessments would require much more extensive work, and expenditures from the Fund, than would be taken in solely a response action. This competition of interests and purposes between victim compensation and cleanup needs must be assessed before decisions are made with respect to appropriate legislation.

Finally, the proposals contain some variation in funding mechanisms. It is critical that we determine whether the funding mechanism is viable and funding levels are adequate to pay claims. An additional funding issue relates to the CERCLA Post-closure Liability Fund. CERCLA established the Post-closure Liability Fund to assume virtually all liability, including for personal injury, and for certain eligible closed land disposal facilities which operated under final RCRA permits. H.R. 2582 sets up a Post-closure Victims Fund which duplicates the Post-closure Liability Fund both in purpose and in tax base. Both Funds would apparently exist side by side with some inconsistencies and differences which would be unresolved by the proposed bill.

EPA Efforts in This Area

Faced by the urgency of some of the issues in this area, EPA has undertaken to further analyze and better understand this critical area. Accordingly, we have commenced a review of legislative proposals focusing on administrative and scientific issues as well as assessing the impacts upon the Agency's substantive programs and its resources.

An important issue that we are investigating is EPA's ability to conduct the kinds of health effects studies required by the various legislative proposals. Our ability to develop these studies relates directly to our capability to answer the scientific questions I highlighted earlier in my testimony.

What Lies Ahead

The Congress faces a substantial undertaking in considering the range of toxic victim compensation issues. At this point, the only conclusion that is clearly evident to me is that we all share a large degree of concern for the victims of hazardous substance exposure, and we at EPA stand ready to assist you and them in any way possible.

Adequate consideration of the full range of toxic victim compensation issues will require coordination, cooperation, and good will within EPA, the Executive Branch, and between the Congress and the Administration as well as with the States, which have a great interest in what is finally decided here in Washington.

It is certainly worth the effort of us all to assure that all parties with an interest in this issue are heard during the Congressional deliberations which will follow today's hearing.

We at EPA pledge to do what we can to assist in this important effort and will keep this Subcommittee and Congress apprised of our activities as well as progress toward the goal of developing more scientific certainty in the area of health effects resulting from exposure to hazardous substances.

This concludes my prepared statement. I would be happy to respond to your questions.

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Calling for broad-based economic relief. . .

ENVIRONMENTAL LAW INSTITUTE PROPOSES TOXIC-VICTIM COMPENSATION FUND

The Environmental Law Institute has recently completed a draft report and model legislation recommending that the federal or state governments create a toxic substances liability compensation act to provide economic relief for victims who have suffered personal damages and "chronic and progressive health effects caused by hazardous substances."

The model hazardous substance victim compensation bill drafted by ELI would be far more encompassing and costly for industry than an earlier proposal by a Superfund-mandated task force of lawyers to create a hazardous waste victim compensation fund (Inside EPA, Aug. 13, p1) because it would provide relief for victims suffering from a broad spectrum of chemically related pollution including non-occupational and occupational harm. As now drafted, ELI says, the fund would be financed initially by a petroleum and chemical feedstock tax patterned after the Superfund's financing scheme, but within five years would be replaced by an industry "hazard fee" whereby the administrator of the fund would develop hazard categories for a maximum of 10 categories. The tobacco and asbestos industries are specifically targeted in the draft to pay a "substantial" share of the money annually collected.

ELI's draft report and model legislation covering over 200 pages is still undergoing review and is subject to change, but the final report is expected to be released this spring. The report, "Statutory reform of 'toxic torts': Relieving legal, scientific and economic burdens on the chemical victim", was prepared by ELI's Jeffrey Trauberman, director of the toxic substances program. The report, part of a three year study addressing a broad range of issues related to toxics, proposes several reforms to current laws to "remedy some of the inequities facing the victims of chemical pollution, recognizing the need to avoid placing arbitrary or punitive costs on affected industries." The ELI report is likely to become part of an emerging debate in Congress on the degree to which victim compensation should be legislated.

Specific reforms recommended in the ELI report include: 1. non-restrictive statutes of limitations; 2. expansive evidentiary rules; 3. broad coverage of hazardous substances; 4. prospective liability requirements; and 5. reform of causation principles. Following is a rundown of the key reforms recommended by ELI and embodied in its model hazardous substance victim compensation bill.

Non-restrictive statutes of limitations. The study says that "statutory reform of liability for toxic substances pollution should contain a limitation period that begins to run from the date a person reasonably should have discovered a connection between injury and exposure to a certain chemical." The model law encompasses a limitation period that allows a person allegedly suffering from a hazardous-substance-caused disease to file a claim "within two years after the covered disease is manifest and such individual, by the exercise of due care, could have established a person who, with reasonable likelihood, caused or was a substantial factor in causing such disease."

Expansive evidentiary rules. Saying that "science and law are uneasy partners," the study notes that "proof of environmentally caused injuries almost always requires the introduction of evidence on the 'frontiers of scientific knowledge'." The model provides that "certain types of non-prejudicial and non-inflammatory evidence are to be considered relevant in proceedings involving toxic substances. These types of evidence include: 1. epidemiological data; 2.results of animal or human laboratory or toxicological studies; 3. test data on microorganisms and tissue samples; 4. information on the correlations between the structures of chemical substances or mixtures and potential to cause or contribute to a covered disease in an individual; and 5. studies of the effects of exposure to two or more chemical substances or mixtures."

Broad, dynamic coverage of hazardous substances. The model bill defines hazardous chemical substance or mixture as: 1. "any chemical substance or mixture for which there is a federal standard (including any law, requirement, tolerance, prohibition, action level or similar legal authority adopted by an agency pursuant to federal law), generally intended to prevent, reduce, or mitigate the risk of a disease or class or type of diseases to an individual or individuals resulting from exposure to such chemical substance or mixture; or 2. any chemical substance or mixture, exposure to which has been designated by the Administrator pursuant to section 216 of this act; or 3. any chemical substance or mixture for which notification has been provided to an individual pursuant to section 207 of this act." The model law also defines "hazardous pollutant" as any "designated, specified, or referenced chemical considered to be a hazardous substance under section 101(14) of Superfund."

Focus on chronic diseases and other uncompensated injuries. The study says the model law "seeks to focus coverage on the areas where reform is most urgently needed. Its primary emphasis is on chronic and progressive health effects caused by hazardous substances. The model bill deals primarily with 'covered diseases' defined to exclude most health-related injuries that arise within one year after exposure to the substance in question in the amounts and for the duration alleged." The draft law defines "covered diseases" to mean: "Any medically verifiable chronic or progressive disease such as cancer, genetic mutations, behavioral abnormalities, physiological malfunctions (including malfunctions in reproduction), and physical deformations in humans or other offspring, or death. A disease shall be considered a chronic or progressive disease if it does not typically manifest itself in humans within one year after initial exposure to the particular chemical substance or mixture under the circumstances in question, unless the trier of fact determines that this criterion is clearly inappropriate in light of the equities and in order to effectuate the purposes of the act. However, in no case shall a disease be denied classification as a chronic or progressive disease, if it manifests itself in a period of greater time than that allowed under otherwise applicable law for filing a claim or lawsuit for damages for such disease of a type specified in section 206(a). In addition, any disease allegedly resulting to an individual from exposure to a hazardous chemical substance or mixture prior to birth automatically shall be considered a chronic or progressive disease under this act."

Prospective liability; prospective and retrospective compensation. The study says that liability under the draft law is primarily "prospective" and that it "bars any person from being held liable for exposures or releases occurring solely in the past." The study continues: "Some persons have suggested that expanded, retroactive liability can encourage persons who have created harm to step forward and ameliorate such harm. While this may be true in limited circumstances, the general effect of such retroactivity is to expose enterprises to punitive and potentially unconstitutional liability. The model statute rejects this 'deep pocket' approach to liability and seeks to encourage safer conduct on the part of enterprises engaging in hazardous activities."

Reform of causation principles. The study says the draft law allows for the limited use of "risk-based compensation" where "sliding scale burdens of proof" are used "that vary according to the risks and benefits of the activity allegedly responsible for them." The study says that the two "primary certainties" which arise in hazardous substances litigation are the 1. difficulty in identifying the substance causing the injury; and 2. the difficulty in linking exposure to that substance with a particular party. It says the model incorporates rebuttable presumptions that "do shift the burden of persuasion," but it says "the statute affects causal requirements in two administrative settings involving personal injuries: 1. workers' compensation claims; and 2. claims against the fund.

Reform of apportionment rules. The model law provides that "where any one of the parties is a substantial factor in causing harm, the party may be held liable for the full extent of the damages suffered by the plaintiff. However, where the court determines that there is a reasonable basis for apportioning liability for the covered disease in question, a person who is a 'substantial factor cause' may limit his liability to the extent that he can bear the burden of proof in establishing the contributions of other causes to the particular disease. Furthermore, the model statute does not incorporate an explicit presumption that diseases are not apportionable among various causes; instead, it adopts the more scientifically sound approach in recognizing that disease etiologies may, in fact, be attributable to multiple agents."

- **Elimination of proof of fault as a prerequisite to compensation.** The study proposed model bill does "not require victims of toxic substances pollution to demonstrate fault in order to recover for the harm they suffer." The study explains: "Compensation of a person for harm caused by a hazardous substance should not be contingent on the ability of that person to prove that another person was at fault or engaged in an unreasonable behavior. Requiring pollution victims to make this showing invites subjective and arbitrary judicial decisionmaking and is generally a process that is weighted against injured individuals. Furthermore, there is no per se economic reason for imposing costs on the basis of fault, such that victims bear harm that is considered too expensive to avoid."

Provisions for a hazardous substances victims compensation fund. The model law establishes a hazardous substances victims compensation fund for the "primary purpose of administering and paying compensation claims." It incorporates a petroleum and chemical feedstock tax, modeled after the Superfund financing system. Petroleum and chemical feedstock payments would be collected starting one year after enactment of the law and no more than five years later a "hazard fee" would be phased in. The study says: "This would be accomplished by assigning hazard categories to various enterprises, depending on their compliance with environmental and public health requirements, and their involvement in claims and lawsuits concerning toxic-substances-related injuries. A substantial portion of the hazard fee would be derived on the manufacturers of tobacco products, asbestos, and asbestos products because these substances are well-recognized causes of harm" — industry would pay 90% of the hazard fee, leaving the government with a 10% contribution. The ELI study says that within 10 years after enactment of the legislation, "monies from the hazard fee would comprise the majority of funds collected each year, and the amount collected from fees on oil and chemical feedstocks would be correspondingly reduced."

The ELI study also says the fund will cover workers' compensation claims "involving chronic disease allegedly resulting from exposure to hazardous substances," the study explaining that "in general, while workers' compensation seems to have worked well with respect to occupational accidents, it has been a wholly inadequate remedy for occupational diseases caused by exposures to hazardous substances." The study also says that in the model law "any recovery a victim might obtain from the fund will be reduced to the extent that the injured person knowingly and voluntarily assumed the risk of injury, considering the information communicated about such risk, and whether one might fairly expect an individual to act upon such information to avoid or mitigate the risk of harm."

Uncompensated environmental losses. The study says that the model legislation, besides providing compensation for chronic and progressive diseases, provides that the fund may be used for the recovery of other uncompensated financial losses (property damage or medical expenses from acute health effects) if such losses "are caused by the release of a hazardous pollutant and compensation is not available from the responsible party."

AFL-CIO on Victim Compensation: A Labor Program for Occupational Disease Prevention and Compensation

by Sheldon Samuels and Brian Turner

There is a clear national need for a federal program to identify, notify, screen, diagnose, aid, and compensate populations of both workers and their families who are at high risk or dying or becoming disabled as a result of an occupationally attributable disease.

The first part of a two-fold program would be administered by the National Institute for Occupational Safety and Health (NIOSH), which would conduct medical research to identify and assist populations at risk and administer a Risk Assessment Board. Coverage for known populations at risk would be based on an epidemiologic trigger. Additional workers would be included as new information is collected through research.

The second part of the program would be administered by a new federal program that would compensate disabled workers and their families through industry trust funds gathered from employers, adjudicate claims, and initiate a national recordkeeping system. Compensation would be virtually automatic where occupation is a factor in causing a worker's disease or disability, on a no-fault basis. Workers and the government would have the right to sue both corporations and individual corporate officers in cases of criminal and gross negligence, and workers would be protected from exclusion from coverage under existing health insurance.

THE PROBLEM

Based on the most current available data, 100,000 workers die and one million are disabled annually because of work-related diseases. Family bystanders may also number among the victims, but the exact toll is unknown. In 1978, only about 10 percent of even the most severely disabled workers received benefits from state workers' compensation systems, which are designed to deal with traumatic injury, not disease.

In some instances, the compensation system has been circumvented altogether. Documented research on the harmful effects of exposure to asbestos, for example, coupled with 30 years of silence on the results, has led to tens of thousands of lawsuits against asbestos manufacturers and their insurance companies by injured workers. One company involved, Manville Corporation, recently filed for bankruptcy in an attempt to force support for legislative relief. While this draws attention to the plight of asbestos-exposed workers, the small number that prevail in court liability actions often receive only limited compensation. Tens of thousands of other victims remain completely uncompensated.

Many workers fail to exercise their right to claim compensation because of the lack of a system of notification and assistance. The percentage of workers compensated for work-related diseases, however, has tripled since 1974 as a result of workers' education programs and broad national publicity about various health hazards. But the number compensated is much lower than the number harmed.

Residual risk (the backlog of exposed people who carry the seeds of disease) plus uncontrolled risk resulting from increased chemical production and inadequate standards, but not offset by decrease in metals, fabrication, and other production categories, mean an alarming continued upward trend. Even if all economic activity were to level off or decrease, the persistence of toxic chemicals, metals, and plastics that recycle, accumulate, and concentrate in the environment means increased risk.

PREVENTING RISKS IS NOT ALWAYS POSSIBLE

Risk to a population does not equal disease or disability or death for all members. Preventive measures that reduce suffering and extend life are available with increasing frequency and effectiveness. These measures, however, cannot be delivered for several reasons, as follows:

(1) Higher risk populations have been approached legally and administratively

* Reproduced with the permission of Aspen Systems Corporation, Rockville, MD from Hazardous Waste Report: Trends and Analyses, Mar. 1983: 13-16.

from the point of view of single causal (explosive) agents or separate diseases rather than as populations. This has resulted in the evolution of a compensation system for legal intervention that is inadequate, inflexible, and unjust; single-cause explanations hinder effective prevention and diagnosis.

(2) Populations at risk have not been identified and notified; and

(3) These populations cannot identify themselves without assistance. Moreover, planning and even tools of planning such as uniform recordkeeping do not exist. Broad capability to diagnose individuals does not exist.

(4) Social and economic incentives for misdiagnosis abound, including: (a) exclusion of occupational disease coverage in health insurance; (b) denials of remedies by rule (e.g., limiting covered diseases) or statutes of limitation for workers' compensation; (c) lack of "paper work" assistance to those afflicted; (d) pressure on employees from management not to file for claims; (e) peer pressure on physicians to accept private life-style fads (such as diet) in diagnosis; (f) teaching workers to accept unnecessary risk.

EARLY RESPONSES FOCUS ON COMPENSATION

The Occupational Safety and Health Act, enacted in 1970, created a national commission to recommend reforms for uniform state workers' compensation systems. Its recommendations, however, were largely ignored. Some systems, such as Florida's, have retrogressed under interstate competitive pressure. Others, such as Ohio's, have been able to preserve what little exists only by a massive expenditure of political energy. The Williams-Javits bill to reform state systems, first proposed in 1973, was defeated by the insurance industry and the Chamber of Commerce. In response to asbestos litigation, special case (single agent) bills were introduced by Representatives Fenwick and Miller and Senator Hart, along the lines of the Humphrey red lung bill. Taft's occupational lung disease bill had been introduced on behalf of asbestos-exposed workers along the lines of the (single disease) black lung law.

All past efforts have focused on compensation. No legislation has been introduced to aid workers and their families in preventing the actual appearance of disease and assisting those with disease. This may be a legislative issue separate from the issues of compensation and liability.

The compensation mechanism historically has taken three forms: court action; no-fault compensation administered as an exclusive remedy system; and a mix of the two. All three remain options for federal legislation.

A UNION PROPOSAL: PREVENTION AND COMPENSATION

A basic legislative framework would involve three main principles. First, a new program administered directly by the federal government is needed, rather than a program that merely requires states to meet federal minimum standards. A separate agency--Occupational Disease Prevention and Compensation Administration (ODPACA)--would be created. The agency would preempt the state role in administering a program for populations at high risk of occupational disease, but would allow state programs for injury. It also would maintain existing state networks used by the Social Security Administration (SSA) for initial medical determinations to establish disability. The agency would administer a Rate Board which would set premium rates based on the risk assessment and production or use data, set up industry compensation funds, provide payment, adjudicate claims, and initiate national recordkeeping and reporting. It also would be charged with systematically notifying individuals in the risk groups and conducting nonmedical (systems) research to strengthen program administration, and would have a strong education unit. The Rate Board would be composed of full-time career civil servants representing medicine, epidemiology, toxicology, industrial hygiene, and engineering, and would serve for six-year terms under strict conflict-of-interest protections.

Second, in its companion role, NIOSH would administer related medical research, identify populations at risk, certify diagnostic centers, demonstrate community high-risk population assistance programs, and administer a Risk Assessment Board that would determine excess risk in a population. The membership of the Risk Assessment Board would follow the same guidelines as the Rate Board.

CRITERIA FOR SYSTEM START-UP

Populations already clearly identified, such as asbestos-exposed workers, would be part of a "start-up convoy" of initial coverage in the statute. Comprehensive coverage would be achieved for a large number of populations using an epidemiologic trigger based on the following criteria:

(1) Exposure to an agent or process established by (a) government notification and (b) worker application.

(2) Human (epidemiologic) data (existing studies) assessment to determine excess risk by site for exposed populations, using the National Cancer Advisory Board's risk assessment definition.

(3) Expansion of assessment and notification as new data is accumulated under an aggressive program of epidemiological research.

(4) Where epidemiologic research has not been done, but one or more cases presents a clear clinical picture, the agency could certify the case and order a population study.

WORKERS' RIGHTS UNDER PROPOSED COVERAGE

Entry: Prior to the manifestation of the disease, membership in a high-risk population would entitle an individual to inclusion into a managed disease control group. Populations would be screened, diagosed, and aided under a strict code of ethics to protect privacy, control records, and maintain the patient-physician relationship. Family members, where appropriate, could be included.

Eligibility: Compensation for disabled victims and surviving dependents would be virtually automatic after a determination of minimum workplace exposure periods. Whenever occupation is a factor in disease causation, this creates a legal presumption for individuals. No fault need be found. A finding of employer negligence is unnecessary, and individual life-style would not disqualify a worker.

Presumption: This would create an absolute right to aid and compensation for a person whose work history establishes membership in a high-risk population, and who contracts an occupational disease associated with an epidemiologically defined exposure to an agent or process. Contributing factors such as smoking or air pollution would be irrelevant.

Other Insurance: Carriers would not be permitted to exclude occupational disease or members of high-risk populations, but could recover costs from corporations or their compensation carriers. Health insurance carriers, profit and non-profit, would set up a pool to insure those who otherwise might be "uninsurable" because of having been identified as members of a high-risk population by the surveillance and diagnosis provisions of the program.

Benefit Levels: Benefit levels would be the same as under the Longshore and Harbor Act, as follows. Benefits in cases of temporary total and permanent total disability would be at least 66-2/3 percent of the worker's average weekly wage, up to a maximum of 200 percent of the national average weekly wage for the duration of the disability. In cases of permanent partial disability, benefits would be at least 66-2/3 percent of the difference between the worker's average weekly wage and wage-earning capacity for the duration of the partial disability. Death benefits would be 66-2/3 percent of the average weekly wages of the deceased worker. The average weekly wage for computation of these benefits would be no less than the national average weekly wage, but benefits would be no greater than the average weekly wage of the deceased. Each year, benefits for permanent total disability or death would be increased by the percentage increase in the national average weekly wage. Compensation awards would offset tort awards, and legal fees in tort cases would be based on the amount above the compensation award. An excess liability fund would cover workers associated with defunct corporations.

Legal Rights: The legal rights of workers to receive fair compensation for occupational diseases under this system would be protected by the right of court appeal. Compensation normally would be the exclusive remedy, but members of high-risk populations and the agency could sue for additional damages against employer corporations under a theory of negligence and for damages against individual corporate officers and employees in all states under theories of criminal negligence or gross negligence.

(a) Negligence: Corporate violation of OSHA or other enviromental statutes, rules, or regulations is prima facie evidence of negligence. Employer compliance with OSHA and other standards is not a complete defense to liability where the employer knew or should have known that standards then in effect were inadequate to protect health.

(b) Criminal Negligence: Where the individual defendant knowingly, willfully, purposefully, or recklessly creates an unreasonable and unjustifiable risk of harm or fails to be aware of a substantial and unreasonable risk of harm, by clear and convincing evidence. (Highest civil standard of proof applied to criminal conduct.) Action could be brought by the state and federal governments through amendments to federal criminal statutes. Workers could sue the government to assure enforcement.

(c) Gross Negligence: By preponderance of evidence, gross deviation from standard of care, creating or failing to recognize unreasonable risk of harm.

TRUST FUNDS FOR EACH INDUSTRY WITH PREMIUMS BASED ON RISK

Trust funds would be created and administered for each industrial category, with at least minimal assessments established for all employers. While companies could participate as self-insurers, they also could be represented by their carriers. The premiums would be set by assessing the risks of occupational disease disability from specific toxic agents and processes.

Rates would be set by a Rate Board administered by ODPACA, based on information from the Risk Assessment Board and production or use data. Traditional experience rating is not possible for chemicals and processes with unknown toxicity, indeterminate effectiveness of controls, and risk manifested in disease that may appear 5 to 50 years after the first exposure. Portions of each fund would be used to provide funds for: 1) compensation; 2) prevention; and 3) administration and research.

Hundreds of new chemical processes are being introduced into industry each year, exposing ever greater numbers of workers to occupational health hazards. Thousands of workers die each year from the effects of asbestos, cotton dust, beryllium, lead, benzene, carbon monoxide, cancer-causing chemical dyes, and pesticides, to which they were exposed, sometimes many years ago. The occupational disease effects of new and changing technology are being borne by workers themselves rather than by the system designed to compensate them. A rational and comprehensive system for compensation of workers who suffer occupational disease is urgently needed.

Working men and women need and deserve a nationwide effort by the federal government to prevent occupational disease and to assist those who are paying the price in pain, suffering, and in the lost ability to provide for themselves and their families for years of inaction by employers and by the states.

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The slim rewards of asbestos litigation

Those people who have filed lawsuits claiming disease or death from asbestos exposure have received only 37¢ for every dollar spent by all parties in such litigation, according to a study by the Rand Corp.'s Institute for Civil Justice. In a review of 24,000 suits, James S. Kakalik, the study's principal author, and other researchers found that over $1 billion has been spent by plaintiffs and corporate defendants in litigation and compensation. Defendants have paid out an average of about $60,000 per claim in compensation and another $35,000 in litigation expenses. Legal expenses incurred by the plaintiffs averaged $25,000, reducing that $60,000 compensation figure to an average $35,000.

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Superfunds and Tort Law Reforms—Are They Insurable?

By RICHARD A. SCHMALZ*

I

The "Superfund" bill enacted in 1980[1] is a federal law that imposes strict liability on certain classes of persons for cleanup costs and environmental harm resulting from the handling or disposal of hazardous wastes. It is the most recent in a series of federal statutes that promise to become the springboard for major tort law changes. Even without the superfunds, there has been considerable interest in tort law reform within academic circles, and the highest courts of many states seem eager to make their own marks in reshaping tort law according to their own views of public policy, but federal legislation can accomplish deeper changes more quickly than a dozen law review articles or judicial decisions, so superfunds and the tort law reform movement will feed on each other with a synergistic effect.

But are superfunds and tort law reforms insurable? The question is timely because a number of studies are under way, among them the study directed by the 1980 Act itself, a separate study by the Rand Corporation under the auspices of the Institute for Civil Justice, and other studies by various American Bar Association committees. Since studies rarely find the present state of affairs satisfactory, we can expect recommendations for affirmative action to correct the deficiencies as their authors see them.

Are superfunds and tort law reforms insurable? My answer is a cautious and qualified yes. The discussion which follows reflects the perspective of my thirty-five-year association with the property and casualty insurance business. Quite naturally, then, I raise points for consideration mainly from an insurance standpoint, but one should not overlook the broader social and economic aspects.

Tort law reform is inevitable. The only questions really open to debate are how it should be accomplished and how sweeping it should be. I believe a federal statute is the only feasible method of achieving the kind and scope of tort law reforms that are likely to remain insurable in private markets. I outline an entirely nonoriginal federal statutory system that I believe would enable private insurance and reinsurance markets to respond to the very high

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[1] Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Pub. L. No. 96-510, 94 Stat. 2767.

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limits of third-party liability insurance needed to support the concept of strict liability. Let us start with the Superfund bill in its 1980 version.

II

In some of the earlier proposals for superfund legislation, strict liability was also imposed for bodily injury and property damage to third persons. As finally enacted, however, Superfund does not include this feature, restricting itself to cleanup costs and environmental harm. Instead, Congress directed a study to be conducted with the assistance of the American Bar Association, the American Law Institute, the Association of American Trial Lawyers, and the National Association of State Attorneys General. The purpose of the study is to help Congress determine the adequacy of existing common law and statutory remedies in providing legal redress for harm to man and the environment caused by the release of hazardous substances. Accordingly, the study goes well beyond the scope of Superfund, as enacted, or its predecessor federal statutes dealing with clean air, clean water, and oil pollution.

The study group has been directed to submit its report to Congress with appropriate recommendations. The recommendations are to address explicitly the need for revisions in existing statutory or common law, and whether they should take the form of federal statutes or the development of a model code recommended for adoption by the states.

III

There is a certain equilibrium between tort liability-compensation principles and the underlying price structure of goods and products produced by a private enterprise economy. If that equilibrium is disturbed substantially, it may have an effect far beyond that which is desirable from a broader point of view.

Since the potential for disturbing the present equilibrium is great, it is necessary to start at the beginning and reexamine the premises on which a tort liability-compensation system may soundly be based under modern economic and social systems.

IV

Two basic general concepts apply to injury arising out of private or commercial activities:

(A) For every injury there must be compensation, regardless of the circumstances. The source of compensation is of secondary importance.

(B) A loss should be borne by the one who suffers it unless there is a good reason to shift it to another. Loss shifting requires justification. It is the exception, not the rule.[2]

Legal systems generally start from concept B. Concept A is by nature a broad social imperative which does not offer much as a means of resolving the competing claims of individuals.

Concept A implies compensation without fault. It serves as the model for a pure no-fault compensation system. Concept B implies some limitation on eligibility for compensation. There must be a good reason for the loss shifting. Let us call this good reason fault or wrong or tort. Concept B then becomes the model for a tort liability system.

Concept B carries with it a conscious choice not to use it or regard it as a means of compensating every injury. Therefore, it should not be a valid criticism of a tort liability system that some injuries or classes of injuries do not qualify for compensation. The chief exclusions are, almost by definition, those cases where there has been no fault in the legal sense and where, if there is such fault, there has been no causal connection between the fault and the injury in a mixed legal and physical sense.

These are the areas subject to the most pressure from critics of the tort liability-compensation system. A process that continuously relaxes the eligibility requirements for tort liability compensation leads to concept A.

As a general rule, the tort liability compensation system in the United States seeks to provide full damages for injury once the necessary fault and causal connection can be found. This requires putting a monetary value on all injuries, difficult though this may be. For bodily injuries, damages include compensation for medical expenses, lost earning capacity, and pain and suffering. The last element is hard to measure by objective standards and yet, in theory and practice, often overshadows the purely economic losses.

No large modern state has fully adopted concept A in a pure form. The administrative burdens and costs for a large state would be so enormous that such a concept is perhaps untenable for those reasons alone. Concept A has been adopted, in greatly modified form, as a part of legal systems. The main examples that come to mind with respect to the United States are workers' compensation and no-fault automobile insurance systems. Both are third-party liability systems that deal almost entirely with bodily injuries rather than property damage.

In each of these cases where the fault eligibility rule has been abandoned, it has been necessary to set the amount of compensation payable substantially below the level of full tort damages. Otherwise the total cost of the system would rise to unmanageable heights. An initial balancing principle emerges.

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[2] Pfennigstorf, *Environment, Damages, and Compensation*, 1979 Am. Bar Found. Research J. 347, 363.

As we move from the concept of fault to no-fault, we must be prepared to accept lower compensation levels or risk unmanageable costs.

Neither workers' compensation nor automobile no-fault systems have eliminated the second important eligibility requirement of a liability system: the causal connection between the third party's activities and the bodily injury. For no-fault automobile insurance the third party's automobile must be involved in the accident and the accident must be the cause of the claimant's injury. In workers' compensation cases the injury must arise out of and in the course of a worker's employment. For most automobile and industrial accidents causal connection is rarely a problem. In workers' compensation occupational disease claims, however, the causal connection between work-related exposure and injury is often hard to establish with certainty.

There has been a trend toward easing the causal connection burden under workers' compensation laws in occupational disease cases. This has resulted in higher workers' compensation insurance costs. An extreme instance is the relaxation of burdens of proof with respect to black lung disease together with the imposition of retroactive liability. The cost explosion these have brought about has caused serious insurance problems and produced a system which may be running out of control from a financial standpoint.

This brings up a second balancing principle. *If we relax the causal connection requirement for a tort liability system, we risk unmanageable costs even if benefits are sharply reduced below full tort compensation levels.*

To achieve a purpose other than merely compensating every injury, the system must be rational and predictable on both the eligibility for and the amount of compensation. If it appears to be arbitrary or capricious, no message emerges by which individuals can be guided to act in accord with the system's purpose.

Interestingly, the condition of predictability is also essential for a system of private insurance operating under market pricing. When insurance is sold under competitive conditions to individual risks, the losses of each risk or group of risks must be predictable in order to determine an appropriate premium charge. When losses for any insured or group of insureds become unpredictable due to changes in the tort liability system, an insurance crisis usually follows. The recent crises in medical malpractice and products liability insurance are prime examples.

Critics are quick to express dissatisfaction with the tort liability system: it does not compensate every injury; at times it imposes difficult burdens of proof on those seeking to shift losses to others; and it has trouble dealing with the causal relation between certain exposures to hazardous substances and late-emerging injuries. A quick reaction is to set about curing these defects by imposing strict liability and by creating presumptions of a causal connection that cannot be rebutted any more convincingly than the connection could be proved directly. But such a course undercuts the rationale of the tort liability system and its predictability and risks unmanageable costs and insurance crises.

V

The ideal foundation for a workable third-party liability system would be a sound, generally accepted definition of: (1) its purpose; (2) the reasons why it is better to shift losses to some third parties than to leave them on the injured person (or the injured person's insurer); (3) who these third parties are; and (4) the circumstances under which the loss shifting is to take place. Such a definition would enhance predictability and promote efficiency from an economic viewpoint. It is not surprising, then, that several American scholars in the legal and economic disciplines have been devoting considerable effort in recent years to developing a comprehensive theory of accident law based heavily on economic theory.[3]

This approach suggests that the major purpose of liability rules should be to reduce the costs of accidents, including the costs of avoiding accidents. The persons liable for accidents would be the cheapest cost avoiders (i.e., they would be in the best position to make a cost-benefit analysis between accident costs and accident-avoidance costs and to take appropriate action). Making such a determination involves applying economic efficiency and utility theories.[4]

Not all legal and economic scholars who have studied the matter believe that it is practical or sound, even theoretically, to base tort liability-compensation rules primarily on promoting an economically efficient allocation of society's resources. Cost-benefit calculations and interpersonal welfare comparisons are difficult, if not impossible, to make with much confidence in most cases.

Englard, a lawyer, notes that "[c]areful behavior may be cheap in itself, but the effective avoidance of all the small human errors would probably exceed the totality of society's resources. A truthful cost-benefit calculus of total accident avoidance would therefore in most cases leave the loss where it falls."[5]

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[3] Perhaps the prime mover in this effort is Guido Calabresi, who has written extensively on this subject. His major work, The Costs of Accidents: A Legal and Economic Analysis (1970), is well known. Richard Posner has developed an economic theory of negligence and contributed many scholarly papers. The Journal of Legal Studies, published by the University of Chicago Law School, is replete with articles devoted to an economic analysis of the law. The three-part series of volume 9 (Jan., Mar., and June 1980) is especially useful in gaining a perspective on the state of American legal and economic scholarship in this area.

[4] For a discussion of some conceptual problems and inconsistencies, see Dworkin, *Is Wealth a Value?*, 9 J. Legal Stud. 191 (1980).

> Utilitarianism supposes that individual welfare levels are at least sometimes comparable, so that total or average utility levels can be ordered over various choices of social programs. Economists, as a group, have been skeptical about interpersonal comparisons of utility. If utilitarianism is to be the motor of wealth maximization, then wealth maximizers must forgo that skepticism and move even further from present orthodoxy in economics.

Id. at 216.

Rizzo, an economist, concludes that

> [e]fficiency, as normally understood, is impossible as a goal for tort law. The law cannot and should not aim toward the impossible. . . . Precisely because we live outside of general competitive equilibrium and in a world of unpredictable flux, the efficiency case for negligence must fail. In such a world it is impossible to compare alternative liability systems, in terms of judicial cost-benefit analysis or "fine tuning."[6]

Some forty years ago, Prosser clearly perceived the social engineering aspect of tort law, writing in his classic *Hornbook on Torts:* "Perhaps more than any other branch of the law, the law of torts is a battleground of social theory."[7]

Twenty-five years ago Harper and James observed that

> [i]n the long run, the law tends to respond to its function and there are strong pressures at work toward making accident law serve at least some of the objectives of social insurance. It is in a transitional stage, where professed doctrine and purely logical reasoning from it will not accurately reflect the course of decisions or furnish a safe guide to what courts will do in the future. However little one may be concerned with law reform he cannot understand what is actually happening to the rules in this branch of law today unless he appreciates the trend towards social insurance and the relationship between this trend and the evergrowing institution of liability insurance.[8]

The process of transition has not slowed down. Englard has more recently (1980) noted:

> In general, the cause of the present crisis can be ascribed to a shifting in the aims and functions of tort law. Traditional tort law has been concerned with redressing a certain wrong committed by the tort feasor towards his victim. It is "corrective justice" between two parties based on the concept of fault with a clear moral connotation: the blameworthy injurer must compensate the innocent victim.
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[5] Englard, *The System Builders: A Critical Appraisal of Modern American Tort Theory*, 9 J. Legal Stud. 27, 55 (1980).

[6] Rizzo, *Law Amid Flux: The Economics of Negligence and Strict Liability in Tort*, 9 J. Legal Stud. 291 (1980).

[7] W. Prosser, The Law of Torts 15 (1941).

[8] F. Harper & F. James, The Law of Torts 784 (1956).

> The growing number of accidents created social pressure for the compensation of the victims, which was facilitated by liability insurance. The consequent penetration of distributive goals undermined the deterrent and retributive function of tort law. The traditional concept of fault itself underwent changes. The persistent tendency towards distributive aims weakened the idea of moral culpability by objectifying the elements of fault and causation.
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> The acute crisis of conflicting aims has been aggravated by the fact that the dominant elements of loss spreading have developed outside the framework of traditional tort law. In particular, the systems of social and private insurance have been created quite independently from specific rules of liability.
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>
> The traditional corrective-justice pattern of tort law has proved to be universally inadequate to overcome this conflict of aims and functions. One has only to consider the frequent case where both tort feasor and victim are covered by insurance. The whole tort process in which the court painstakingly labors to elucidate the minute facts of the damaging occurrence appears futile in view of the final allocation of the loss. The actual result of the trial may simply be a mode of accounting between two big insurance agencies. It is little wonder that modern tort law has been described as "schizophrenic, at cross-purposes."[9]

These observations show that, unfortunately, there is not much chance of identifying any single unambiguous, universally accepted purpose underlying the tort liability system. The emphasis will continue to shift toward concept A with less and less importance attached to individual responsibility or fault. Several legal theories now allow a plaintiff to avoid the burden of proving that an individual firm caused harm if the plaintiff can show that the firm is one of many firms marketing essentially the same product. Strict liability is favored over negligence by several scholars.[10] Some would argue against allowing even contributory negligence as a defense on the claim that it promotes economic efficiency,[11] although others do not agree.[12]

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9. Englard, *supra* note 5, at 27-29.

10. *E.g.*, Epstein, *A Theory of Strict Liability*, 2 J. Legal Stud. 151 (1973). But note a partial retreat for products liability, R. Epstein, Modern Products Liability Law 28 (1980):

> The arguments just made on behalf of strict liability, even if conclusive in cases involving strangers, to which they apply, are therefore of but limited relevance in products liability situations. They say in effect that strict liability and not negligence should govern whenever an innocent bystander is injured by a defective product made and marketed by the defendant. These same arguments are, however, of no particular relevance to the vast bulk of products liability actions brought by purchasers, users, and consumers of particular products.

Striking a fair and reasonable balance between emphasizing compensation and retaining the concept of individual fault in the traditional sense requires thoughtful consideration of important public policy questions. As we move from concept B (the fault-based corrective-justice system) toward concept A (the pure no-fault compensation system), the scarce resources available to society will be reallocated in different dimensions and directions. American goods and services will cost consumers more, and American industry may become less able to meet foreign competition unless compensation levels are lowered from present tort standards and the distribution costs of the tort system are improved.

One implication of this shift is that lawyers will become less and less involved in pressing accident claims. The system will become more automatic, more like social security. Another is that general damages will have to be reduced or eliminated. All this will bring forth strong opposition from the bar. No doubt claims will be made by some advocates of change that in addition to providing more adequate and more just compensation, society will benefit greatly by a stronger impetus toward accident prevention and "internalization" of costs. These claims are window dressing. The truth is that the more the concept of individual fault is eroded, the less effective the transfer of loss is as a spur to accident-proof conduct; the weaker the causal connection between a tort feasor's activities and an injury that has many possible causes, the greater is the chance that somebody else's costs are being "externalized."

The policy questions involved in an accelerated shift toward more liberal tort liability rules need a solid economic analysis, although perhaps not along the same lines taken by the economic school of tort liability reformers mentioned earlier. I believe that many of these reformers have overemphasized the ability of the tort system to deter unsafe conduct as it evolves to strict liability and more relaxed compensation rules. In any event, it appears that they have not carried the analysis far enough in relation to the ability of society to afford full tort compensation under such conditions.

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11. *See* Rizzo, *supra* note 6, at 317. Rizzo, however, backs into this position. He demonstrates that it is impossible to make the cost benefit analyses needed to determine efficient liability assignment under negligence and foreseeability tests. He prefers strict liability because it is simpler and results in "greater certainty about the locus of responsibility for accidents. This greater certainty promotes efficiency in the basic institutional sense because property rights, in effect, become more clearly or definitely defined." Rizzo, as he of course intended, has abandoned the classic definition of economic efficiency and substituted a new concept of institutional efficiency.

12. Rubin, in *Predictability and the Economic Approach to Law: A Comment on Rizzo*, 9 J. Legal Stud. 319, disputes Rizzo's claim for increased efficiency, even as Rizzo has redefined it, concluding at 334: "Adding a non-economic standard of liability, as proposed by Epstein and defended by Rizzo, would also substantially add to decision-making costs." See also Shavell, *Strict Liability versus Negligence*, 9 J. Legal Stud. 7, n.11 (1980): "It is of course clear that under strict liability without the defense the outcome is inefficient, for victims would have no motive to take care."

Any compensation system is only as good as the financial resources behind it. Heavy reliance will be placed on some form of private or government insurance. If the present mood in Washington continues, there will be more interest in private solutions to the problem of making sure that adequate security is in place. If costs of the tort system escalate, the private solutions may look more like government-sponsored quasi-private funds drawing their resources from special assessments or fees.

Accordingly neither the insurance industry nor industry as a whole can overlook the importance of the economic analysis suggested above. One must ask what kind of a system is rational for America, and in a changing world what kind of system will maximize the development of efficient private insurance markets to support it.

VI

The private insurance market in the United States has developed two kinds of insurance to accommodate the traditional fault-based, corrective-justice tort system. This is the system that applies to almost all commercial activities. For those cases where the loss is shifted from the victim to a tort feasor, third-party liability insurance is available through insurance policies issued to each firm. The policies indemnify against legal liability. Loss is shifted initially from the firm to the insurance company. The insurer in turn shifts it to its other policyholders, reinsurers, and stockholders. Unless the firm is a very small one, however, the firm's own loss experience will have a marked, direct effect on the firm's insurance premiums under the usual experience rating, retrospective rating, and dividend plans applicable to commercial liability insurance. The larger the firm is, the more likely it is that over time its own losses will determine its own premiums.

The wide popularity of experience rating, retrospective rating, dividend, and cash-flow plans demonstrates that firms are almost universally interested in insurance that reflects their own experience as individual productive units whenever that experience measures their true loss potential reasonably well. The cost of at-fault accidents is, then, largely internalized, often even to individual firms, but if not that specifically, at least to rating classes made up of firms conducting similar activities. In the main, group liability insurance policies have not become widely popular.

For those cases where traditional tort principles do not shift the loss from the victim, first-party coverage is widely available through individual policies issued to victims or to their employers.[13] Losses covered include physical

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[13] The Interagency Task Force on the Health Effects of Ionizing Radiation, in the Report of the Work Group on Care and Benefits (June 1979), notes at 34 that:

> Many persons have coverage under a private health insurance plan which pays benefits regardless of an injury's cause. In 1975, an estimated 168 million persons or nearly 80 percent of the population had coverage for hospital care, and a majority had some protection

damage to homes and business property, vehicles, death, disability, hospitalization, medical expenses, and so forth. In this area, group policies are more common and there is less tendency to differentiate finely among the loss potential of individual victims.

A possible partial explanation of the wider use of group policies is that fault is not a consideration in the determination of benefit eligibility. Losses are, therefore, shifted from the individual to larger, less refined rating classes. The compensation available through first-party coverage is generally restricted to economic loss, except for life and accident insurance, and often has sublimits on benefits for medical expenses or work loss to discourage overutilization.

I do not intend to suggest that the combined third-party and first-party systems do not have any gaps that leave some victims without compensation for some injuries or losses. I wish mainly to outline the general scope and nature of the two forms of private insurance that have evolved to accommodate the traditional concept B approach to tort law loss shifting.

The outline points out, however, that the present practice of issuing third-party liability insurance to individual firms under various experience rating plans supports the corrective-justice and accident-deterrence rationales of a tort liability system. And the nature of first-party insurance, with its generally more-limited approach to compensation levels, suggests that if one tries to fill all gaps in the total compensation scheme by expanding eligibility under the tort system, then the possibility of an unmanageable cost explosion becomes real indeed. The tort system has much higher frictional costs and compensation levels than first-party insurance systems.

The private insurance system has been able to accommodate strict liability as a substitute for negligence, and the weakening of certain defenses such as contributory negligence, when there is a clear causal connection been a firm's activities and an accident. For example, aircraft accidents can be dealt with on a strict liability basis without eroding the corrective-justice or accident-deterrence goals of a tort liability system. In this case, the predictability of aircraft accidents and the proper allocation of losses to a single firm is not undercut by a strict liability rule.

The insurance system begins to have serious problems when strict liability is imposed on numerous firms at the same time for the same injury, especially when the injury cannot be causally linked to any particular policyholder, time period, or industrial activity. The chaotic situation with respect to liability and insurance coverage for asbestos-related injuries is a prime example of how marked shifts away from the requirement of clearly

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against the cost of physician's services, surgical care, and prescribed drugs. Most of the growth of private health insurance has been in employee group plans. However, approximately 18 million people do not have any health insurance or access to free care, and more than one-half of all Americans do not have adequate health insurance coverage for the catastrophic expenses which may result from cancer.

identified individual fault and causation as the basis for liability can create havoc for an insurance and industrial system geared to those principles.

The case for moving the tort liability rules for hazardous wastes even closer to liability without fault or specific causation rests largely on characteristics of the disposal of chemical wastes, which are thought to be analogous to the handling of asbestos. There are many firms that have been engaged for many years in producing industrial wastes. Injuries often become manifest long after exposure. And, as far as we know, the injuries may just as well result from natural or other unidentified causes. At best there is a statistical indication of an increased frequency of injury over the rates observed under other conditions.

It can be expected, then, that a general easing of the loss-shifting burden with respect to hazardous wastes will have the same effects on industry and insurance as those we are seeing in asbestos and black lung cases unless great care is taken to control costs and minimize impediments to a sound private insurance system. I believe there are some steps that can be taken to do this, without passing judgment on the wisdom of expanding tort liability remedies for hazardous waste disposal activities.

VII

If a tort liability system is to impose strict liability and still retain any appreciable element of its historical corrective-justice or accident-deterrence function, it should place strict liability on one and only one firm at a time. And where one firm is to be held strictly liable that firm should be the only firm liable to the injured persons.

Spreading strict liability over every firm forever cannot possibly encourage economic efficiency.[14] Nor can an insurance market respond with peak efficiency to such a condition, or to a condition where one firm is strictly liable at one time but all other firms remain liable on some other ground forever.[15]

Fortunately, we do not have to create a new tort liability-insurance system out of whole cloth. There are some well-conceived models designed to maximize insurance capacity under the rules of strict or absolute liability. These models arose in the late 1950s and the early 1960s to deal with the production and use of atomic energy on a wide scale for peaceful purposes.

In the United States we are more familiar with the Price-Anderson Act of

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[14] There is a problem of plurality here. Not every firm at all times can be "the cheapest cost avoider." Note also Shavell, *supra* note 12, at 465: "Under strict liability it is not hard to imagine circumstances where a party decides against engaging in an activity when it would have been socially worthwhile for him to have gone ahead."

[15] This seems obvious to those in the insurance business, but the point has also been recognized by outsiders. Note Pfennigstorf, *supra* note 2, at 419: "The growing tendency to impose strict liability for large-scale industrial pollution has greatly increased the demand for liability insurance protection but has also multiplied the problems of evaluating the risk exposure, defining reasonable limits for the coverages, and calculating adequate prices."

1957.[16] The Paris Convention of 1960 and the Vienna Convention of 1963 covered similar ground. All have common features that would be useful in treating the liability and insurance problems associated with hazardous wastes. All are designed for risks of an exceptional character for which common law rules and practices are not suitable.

First of all, *they are not general purpose systems.* They focus only on the *exceptional risks* associated with a certain type of industrial activity. In their case, the activity is the production and use of nuclear material, including the supply of parts, materials, and equipment; the transportation of nuclear materials; and the treatment, processing, or disposal of nuclear wastes.

Whenever risks, even those associated with nuclear activities, could properly be dealt with through existing legal processes, they were left outside the system. This feature, which was adopted both in the United States and in Europe, requires the identification and separation of the low-hazard activities from the high-hazard risks. The separation has actually been made on several bases, such as the type of production or utilization facility involved, the nature of the particular activity, the quantity and type of nuclear material at hand, and the seriousness of the consequences of an accident.

While there was considerable philosophical debate in some quarters about the appropriateness of a "threshold" concept, the best judgment of the many experts here and abroad who considered the insurance and liability problems was that a reasonable threshold is required as a balance to the imposition of strict or absolute liability and the expanded eligibility for compensation that arises once the threshold is crossed. The threshold concept also allows insurance companies to develop the most efficient means of providing high limits of coverage for the exceptional, high-hazard risks while retaining their normal practices for the less hazardous risks. High-hazard risks are particularly suited to pools, but pools are not the best or most efficient means of insuring low-hazard activities.

The second feature of the atomic energy models is that, directly or indirectly, strict or absolute liability is the rule. The drafting comments on the Paris Convention emphasize that "[t]his does not, however, mean that merely to engage in a nuclear activity or to transport nuclear substances is to be considered in itself as a presumption of fault; but where an incident occurs, the liability of the operator of the nuclear installation concerned is absolute."[17]

The implication of this comment is that the drafters of the convention are not adopting a concept of enterprise liability. There must be an actual causal connection between the installation concerned and the incident giving rise to the injury. This conclusion is strengthened by the third feature. Directly or indirectly, all liability is channeled to one person—usually the operator of the nuclear installation where the nuclear incident occurs.

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[16] Pub. L. No. 85-256, 71 Stat. 576.

[17] The English text of the Paris Convention of July 29, 1960, with the drafting comments, is included in Joint Committee on Atomic Energy, Selected Materials on Atomic Energy Indemnity Legislation, 89th Cong., 1st Sess. 256-90 (June 1965). The quotation is at 274.

The conventions accomplish this by provisions that explicitly state that only the operator is liable for nuclear incidents at installations. Price-Anderson reaches the same result indirectly by requiring operators to maintain liability insurance or other equivalent financial protection covering not only the liability of the operator but also that of any other person.

The Price-Anderson approach is a practical method of channeling exclusive liability onto the operator of nuclear installations because the total number of installations is still rather small (about seventy) and is likely to remain so. Furthermore, the insurance is furnished through two pools which cross-reinsure each other. Together these pools have attracted nearly all of the free world insurance and reinsurance capacity. Possible cumulation of exposure is eliminated under liability policies issued to suppliers and transporters by standard exclusions of the nuclear hazard. However, their liability is covered under the policies issued to the nuclear installations. Strict liability is imposed for "extraordinary nuclear occurrences" (a threshold based mainly on off-site radiation levels, number of persons with immediate signs of injury, and dollar amounts of property damage). This liability does not stem from statutory changes in underlying state tort law, but from compulsory waivers of traditional common law defenses in the financial protection requirements of the Price-Anderson Act, the Nuclear Regulatory Committee's regulations, and the underlying insurance policies.

We probably could not construct today a similar, essentially nonstatutory channeling of exclusive and absolute liability for nonnuclear waste handling and disposal activities. The nuclear conventions, which require statutory implementation at a federal level, will therefore serve as more appropriate models. The Paris Convention is worth study because of its helpful drafting comments and its careful treatment of the key concept that, with rare exceptions, only one operator is liable for the injury resulting from a nuclear incident.

The nuclear fuel cycle can be divided into three segments: (1) the refining, fabrication, and production of nuclear fuel; (2) the utilization of the fuel or radioactive by-product materials; and (3) the handling, storage, and processing of waste. The transportation hazard can arise at several points in the chain, creating another distinct group of firms called transporters.

A similar cycle can be constructed for other toxic or harmful substances which result in hazardous wastes. We might classify the production and utilization facilities as generators, the waste handlers as waste disposal sites, and the remaining firms as transporters. This similarity of higher-risk sources can be kept in mind while reviewing the liability rules for nuclear activities.

Under the Paris Convention the operator of a nuclear installation is liable on proof that damage or loss was caused by a nuclear incident involving nuclear fuel, radioactive products, or waste in, or nuclear substances coming from, the installation. There are some exceptions for transportation accidents and some priorities when more than one nuclear installation is involved.

In accidents involving the transportation of nuclear substances, the direction of transportation becomes important. The operator of the nuclear installation *from which* nuclear materials are being shipped is the focal point. This operator is liable for a nuclear incident outside the installation if (but only if) the incident occurs: (1) before liability with regard to nuclear incidents involving the nuclear substances has been expressly assumed by written contract by the operator of another nuclear installation; or (2) in the absence of such an express assumption, before the operator of another nuclear facility has taken charge of the nuclear substances.

The operator of a nuclear installation *to which* nuclear substances are being transported is similarly liable for a nuclear incident outside that installation only if the incident occurs: (1) after he has expressly assumed liability by contract; or (2) in the absence of such an assumption, after he has taken charge of the nuclear substances.

The operator liable under the Paris Convention must provide the carrier with a certificate issued by or on behalf of the insurer or other financial guarantor furnishing the security required by the convention.[18]

The priorities under the Paris Convention are as follows:

(1) If the nuclear fuel or radioactive products or waste involved in a nuclear incident have been in more than one nuclear installation and are in a nuclear installation at the time damage is caused, no operator of any nuclear installation in which they have previously been shall be liable for the damage.

(2) An exception is made to rule (1) for damage caused by a nuclear incident occurring in a nuclear installation and involving only nuclear substances stored therein incidentally to their carriage. In such cases, the operator of the nuclear installation shall not be liable where another operator or person is already liable.

(3) If the nuclear fuel, radioactive products, or waste involved in a nuclear incident have been in more than one nuclear installation and are not in a nuclear installation at the time damage is caused, no operator other than the operator of the last nuclear installation in which they were before the damage was caused or an operator who has subsequently taken them in charge shall be liable for the damage.

A catchall clause provides for joint and several liability in the rare case where more than one operator becomes liable under the Paris Convention. If it is a transportation accident involving the same means of transport, or, in the case of storage incidental to transportation, in the same nuclear installation, the maximum total amount for which the operators are liable is limited to the ceiling on liability established by the convention, and no one operator is required to pay more than the operator's individual ceiling.

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[18] There are optional provisions under which the carrier, at the carrier's request, can be held liable for transportation accidents in place of an operator who would otherwise be liable.

The liability provisions of the convention expressly state that the right to compensation for damage caused by a nuclear incident may be exercised only against an operator liable for the damage in accordance with the convention or, if a direct right of action against the insurer or other financial guarantor is given by national law, against the insurer or other financial guarantor.

No other person shall be liable for damage caused by a nuclear incident, except that the convention does not affect the liability of any individual for certain damage to nuclear installations or means of transport resulting from an act or omission of that individual done with intent to cause damage.

This summary of the Paris Convention shows the care taken by the drafters to focus liability on one operator, usually the one in charge of the nuclear material by possession or the last possession.

The drafting comments explain that two factors have motivated the channeling of all liability onto the operator in derogation of the rights of an injured person to sue the person causing the damage under the law of torts. First was the desirability of avoiding difficult and lengthy questions of complicated legal cross-actions to establish in individual cases who is legally liable. Second was the need to avoid special insurance which would otherwise be necessary to cover the liability of all those who might be associated with the operation of a nuclear installation as well as the liability of the operator, which would be very expensive and might not be available.

The principles underlying the convention's approach to establishing liability rules seem far sounder from an insurance point of view than many of the superfund-like proposals. These in the main have no threshold, impose absolute liability without limit on a plethora of potential defendants, and are not exclusive of other remedies. Proposals of this nature magnify the insurance problems which are already becoming nearly unmanageable under the present expanding tort liability rules in the United States.

For the purist, the Paris Convention rules will not serve fully the traditional principles of individual corrective justice embodied in the tort law. But because they do require a clear identification of a particular installation, the imposition of strict liability is not nearly as ambiguous as it is under enterprise liability. It is also more likely that costs will be internalized.

How might the Paris Convention rules be used to construct a new tort liability-insurance system in the United States for nonnuclear hazardous substances?

VIII

The new system would require a federal statute, perhaps modeled on the Price-Anderson Act, but with additional features. The major functions of the statute would be:

(1) To identify the area of application, for example, the generators,

disposal sites, and transporters of hazardous wastes
(2) To set the threshold above which strict liability will apply
(3) To set out the rules imposing strict liability on only one firm
(4) To set out the limits and means of providing financial protection
(5) To set an overall ceiling on liability at a reasonable level
(6) To set reasonable limitations on damages recoverable
(7) To establish exclusive liability under the federal statute; that is, to preempt state tort law

It may be necessary to require a higher level of financial protection than the amount of insurance now customary. This would be the quid pro quo for the limitation on liability for all injuries which are the result of a single incident. While the ceiling should not be unreasonably high (perhaps in the range from $500 million to $1 billion), it will probably exceed the amount of private insurance available for some time. It may therefore be necessary to split the total financial protection into two segments. Primary financial protection could be set at the maximum available from private insurance companies. Secondary financial protection could be made up by a participating plan financed by equitable contributions from all generators, waste disposal sites, and, if desirable, transporters.

The primary financial protection serves two purposes. It guarantees that a fairly high level of funds will be immediately at hand to discharge the liability of the firm that is strictly and exclusively responsible. This ensures a prompt response. The finger is pointed at one firm and one insurer. It also internalizes a fairly high level of cost on the firm that is identified as being strictly liable under the statute. The liability rules based on the Paris Convention would do a good job of putting liability on the firm that has perhaps the best opportunity to avoid the accident. This brings both the liability rules and the insurance system into harmony with the more traditional tort law objectives and the newer economic efficiency arguments.

The secondary financial protection operates as a "stop loss" for the firm exclusively liable. At the secondary level the financial burden of exclusive strict liability is spread to the industry as a whole. One might look at it as a form of enterprise liability but at an excess level.

The justification for enterprise liability at an excess level is that strict liability does not require or even make an inquiry into fault. To saddle one firm with both strict and extremely high liability at the same time is unjust. Other potential or actual contributors to the loss, immune from direct liability, should shoulder some of the burden. Excess enterprise liability is a method of providing contribution or subrogation rights which avoids a series of costly cross-actions or "actions over" based on traditional tort principles.

Secondary financial protection lends itself to a pooling arrangement. It can be totally postloss funded as under Price-Anderson, or partially prefunded and partially postloss funded. The legislation should allow private insurers to participate in the secondary financial protection and to have the same tax advantages as would be given to a government-created pool or fund.

Under a statutory structure as outlined above, using the Paris Convention rules, it should be possible for a vigorous private insurance market to develop for all firms subject to the federal system. The features which would strongly encourage a private system are:

(1) For all operations of all industrial firms except those involving materials or activities that fall under the regime, normal insurance markets can be maintained. These markets can respond at lower cost and greater capacity knowing that the higher-hazard activities will not be covered by their normal policies.

(2) For the higher-hazard activities the special coverage will be channeled to a relatively few clearly identified firms. These firms will be licensed and will be required to maintain adequate financial protection.

(3) Primary financial protection will be available from single insurers, but in addition there are likely to be one or more competing pools. These sources can specialize in the insurance of the higher-hazard activities. They can marshall the underwriting, loss-control engineering, and high-capacity reinsurance facilities needed. Reinsurers particularly will be able to participate to the maximum, knowing that they will not be subject to cumulation of liability through their reinsurance of other activities.

(4) The cost of processing claims and handling litigation would be greatly reduced as multidefendant litigation would be eliminated. Today the cost of defending industrial third-party liability claims is becoming almost as significant to insurers as indemnity payments. The astronomical cost of complex litigation is operating as a brake on insurance capacity in many areas.

There are some potential drawbacks in this type of system for insurance companies. The channeling of strict liability to a relatively few target firms carries with it an obligation to provide high limits to those firms. This may require pooling, a device which a number of companies do not view with favor. However, such a statutory scheme as outlined above probably will not provide greater need for pools or more encouragement to the formation of industry captives than will the rapid development of state tort law in the direction of enterprise liability. If the risks are large and the limits of insurance required are high, the sources of insurance also have to be large. This encourages pooling with or without a federal system.

IX

I believe that the trend of state tort law towards strict enterprise liability cannot be stopped. That being the case, it seems wiser to work for a uniform strict liability system that will result in a higher percentage of premiums (or loss dollars) going to the injured persons. The great expense of operating a traditional tort law system that has largely abandoned its traditional loss-shifting premises can hardly be justified.

Strict liability systems, however, can easily run out of control. They can make it impossible for private insurers to provide high-limit liability coverage at reasonable cost. They may also impose such heavy burdens on industrial firms that they will not be able to compete in world markets.

An approach which may have a broader appeal is to adopt strict liability with certain controls and features. These should strike a balance between (a) the eligibility rules for and the levels of compensation to injured persons and (b) reasonable limitations on industrial liability. If this liability is backed by solid financial protection from private sources, including insurance, those injured through industrial activities will be assured of greater total compensation than under the present hit-or-miss tort system.

The argument is often made that any limitation on the liability of private enterprises constitutes an unjustifiable subsidy as well as an infringement of the rights of claimants. This is a simplistic argument. There are three important practical limitations on the liability of private firms—the corporate form of organization, which limits liability to the corporation's assets; bankruptcy; and competition from world markets. Imposing unlimited liability for injuries is hardly worthwhile if there is not enough money to pay for the claims or if it destroys the source of private funds and jobs.[19]

The concept of a ceiling on liability does not imply that no further compensation for injured persons is justified. The concept recognizes that a ceiling is needed in return for expanded eligibility for compensation and that, above a certain point, there is no good reason under tort law to shift the loss to private third parties. Concept B forms the rational basis of tort law. It holds that loss shifting requires justification and is the exception, not the general rule. A formal statutory ceiling on liability (or the de facto ceiling imposed by the practical limitations on liability mentioned above) still leaves room for first-party insurance and governmental assistance.

The most important benefits of such a statutory system are that it will greatly improve the ratio of dollars paid to injured persons to the dollars paid for the system's operating costs and that it will enhance the ability of private industry, including the insurance industry, to marshall the funds needed to discharge the high level of absolute liability imposed.

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[19] Shavell, *An Analysis of Causation and the Scope of Liability in the Law of Torts*, 9 J. Legal Stud. 463 (1980), states in more elegant fashion four sound reasons for limiting the extent of liability: (1) it may help spread risks; (2) it reduces the likelihood of the injurer being discouraged from engaging in a socially worthwhile activity by a crushing burden of liability; (3) if the probability of a high loss is underestimated, holding the injurer liable for the total loss does not increase the incentive to take care; (4) the potential for problems with multiple injurers makes it difficult to place liability too far out in the (unending) sequence of events flowing from the defendant's act.

Id. at 499-500.

CHAPTER IV

LIABILITY FOR DISPOSAL OF TOXIC WASTES: SELECTED REFERENCES

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I. BACKGROUND

This section is in two parts. Part A, Toxic Waste Management considers methods of handling hazardous waste, including where it comes from and how it might be rendered harmless, also included are references to some of the better known instances of toxic waste pollution and some reactions to them. Part B, Legislation and Regulation focuses on the law concerned with the management of hazardous waste and on the Superfund Act, which is concerned with cleaning up hazardous waste dumps, also with the Federal and State regulatory agencies which enforce these laws.

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Clean-up and fix-up costs rise relentlessly. Conservation Foundation letter, Mar. 1983: 1-8.

"A salient question for society is whether the steadily mounting costs of dealing belatedly with environmental and other critical systemic problems are a serious drag on the nation's physical and economic health."

Desmond, Michael. The disposal of poisonous chemicals. In Extension of remarks of Jack F. Kemp. Congressional record, v. 124, Sept. 21, 1978: 30810-30812; Sept. 26: 31775-31777, 31789-31791.

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The authors describe the trend toward hazardous waste reduction, recycling and resource recovery. They identify legislative actions taken at the Federal and State levels to encourage waste reduction and recycling. Included is a portion of an EPA background information report titled 'The Waste Exchange Option.'

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At head of title: 96th Cong., 2d sess. Committee print.
"Serial no. 96-13"

Goldfarb, William. Kepone: a case study. Environmental law, v. 8, spring 1978: 645-662.
Describes the production of kepone in Hopewell, Va., and the effect the industrial wastes discharged in the production process have had on the health of workers and the water quality of the James River. Discusses the legal cases brought against the chemical companies involved.

Helsing, Lyse D. Protecting the environment. Chemical week, v. 131, Aug. 18, 1982: [unpaged]
A series of articles describes the hazardous waste disposal industry, the services it provides, and the industry's response to Federal legislation and regulation. This special advertising section was prepared by the Institute of Chemical Waste Management.

Highland, Joseph H. Hazardous waste: what is being done to control its disposal? Vital issues, v. 31, Dec. 1981: whole issue.
"While some progress toward proper waste disposal can be observed, we are nevertheless very far from the uniform use of practices that ensure that waste disposal today will not threaten public health and environmental quality in the future."

Hileman, Bette. Hazardous waste control: are we creating problems for future generations? Environmental science & technology, v. 17, July 1983: 281A-285A.
Outlines types of treatment available, risk assessment and government regulation of hazardous wastes.

Industrial and hazardous wastes impoundment, by Nicholas P. Cheremisinoff and others. Ann Arbor, Mich., Ann Arbor Science Publishers, c1979. 475 p.

Jones, Jerry L. Disposal of hazardous industrial wastes: a major environmental issue for the 1980s. Menlo Park, Calif., SRI International, Business Intelligence Program, 1980. 28 p.

Josephson, Julian. Immobilization and leachability of hazardous wastes. Environmental science & technology, v. 16, no. 4, 1982: 219A-223A.
Emphasizes the need for further research "for ways to measure leachebility, permeability, and immobilization; and to monitor these parameters, which eventually would qualify as standard methods scientifically and technically."

Jurinski, Neil B. Incineration or landfill--exploring the waste disposal options. Hazardous materials management journal, v. 2, Nov.-Dec. 1980: 12-16.
"Hazardous waste disposal has become a difficult area. Incineration and landfill are two choices discussed in light of new disposal regulations."

Kneese, Allen V., and Blair T. Bower. Environmental quality and residuals management; report of a research program on economic, technological, and institutional aspects. Baltimore, Published for Resources for the Future by the Johns Hopkins University Press, 1979. 337 p.
Includes bibliography, p. 306-325.

Langner, Paul. Danger: chemical wastes. Boston globe, May 25, 1980: 15, 22; May 26: 21, 26; May 27: 17, 19.
This series of three articles deals with toxic waste in Massachusetts where it has been accumulating for 100 years, much of it in illegal dumps. Cost of cleanup and problems of future disposal are discussed.

Lennett, David J. Handling hazardous waste: an unsolved problem. Environment, v. 22, Oct. 1980: 6-15.
Discusses the issues involved in the hazardous waste disposal dilemma, presents the arguments of both the Chemical Manufacturers Association and the EPA and examines the Superfund legislation designed to establish liability and compensation in hazardous waste disposal cases.

Levine, Adeline. Love Canal: science, politics, and people. Lexington, Mass., Lexington Books, 1982. 263 p.

Main, Jeremy. Dow vs. the dioxin monster. Fortune, v. 107, May 30, 1983: 83-86, 88, 90-91.

Presents both sides of the dioxin controversy. Suggests that the Dow Company has treated its toxic waste very responsibly but that "the company's posture on dioxin comes across as cavalier" and concludes: "still, the law clearly needs stiffening and improvement, just as Dow needs to adopt a more open, less belligerent stance."

Marinelli, Janet. It came from beneath Long Island. Environmental action, v. 14, May 1983: 8-12.

"The groundwater aquifer beneath Long Island's suburban sprawl has become an industrial sewer because of toxic dumps, poor land use and the misuse of dangerous pesticides on East End farms. Vinyl chloride, benzene, aldicarb and trichloroethane are but a few of the contaminants that have leached into the drinking water of three million residents."

------ No room at the bin, by Janet Marinelli and Gail Robinson. Progressive, v. 45, Dec. 1981: 22-27.

The authors suggest that high technology is not the solution to our increasing solid waste disposal problems. They propose an integrated waste management program at the community level.

Maugh, Thomas H., II. Disposal of hazardous wastes. Science, v. 204, May 25, 1979: 819-823; June 1: 930-933; June 15: 1188-1190; June 22: 1295-1298.

A series of four articles: Toxic waste disposal a growing problem.--Hazardous wastes technology is available.--Incineration, deep wells gain new importance.--Burial is last resort for hazardous wastes.

Morell, David, and Christopher Magorian. Siting hazardous waste facilities: local opposition and the myth of preemption. Cambridge, Mass., Ballinger Pub. Co., 1982. 266 p.

National Research Council (U.S.). National Materials Advisory Board. Committee on Disposal of Hazardous Industrial Wastes. Management of hazardous industrial wastes: research and development needs. Washington, National Academy Press [available from NTIS] 1983. 85 p. (Publication NMAB-398)

NATO CCMS Symposium on Hazardous Waste Disposal (1981 : Washington, D.C.) Hazardous waste disposal [proceedings] Edited by John P. Lehman. New York, Plenum Press, 1983. 396 p.

"Published in cooperation with NATO Committee on the Challenges of Modern Society."

Piasecki, Bruce. Beyond dumping: the surprising solution to the Love Canal problem. Washington monthly, v. 14, Jan. 1983: 42-46, 48.

Urges that toxic wastes should not be dumped but should be recycled. Outlines chemical, mechanical and biological techniques available to do this and questions the advisability of EPA's policy of dumping in, for instance, 100-year flood plains.

Piasecki, Bruce and John Rembetski. The chemical companies that crave strict regulation. Business and society review, no. 44, winter 1983: 41-45.
"Without tough government regulation of hazardous waste dumping, detoxification technologies can't compete."

Pojasek, Robert B. Stabilization, solidification of hazardous wastes. Environmental science & technology, v. 12, Apr. 1978: 382-386.
Describes the stabilization-solidification process of converting hazardous wastes into nonhazardous substances. Stabilization converts toxic waste components into a chemical form more resistant to leaching while solidification eliminates the need for a secured landfill.

Polkowski, Frank J. Hazardous waste disposal: a staggering problem. GAO review, v. 16, summer 1981: 42-46.
A senior GAO evaluator outlines the problems of disposal and emphasizes the need for additional legislation, new technologies, and an equitable solution to the problem of locating disposal facilities which no one wants.

Rademacher, John M. An affirmative approach to hazardous waste management. Hazardous materials management journal, v. 2, Nov.-Dec. 1980: 8-11.
Focuses on Velsicol Chemical Company's control of their former waste disposal sites in Hardeman County and Chattanooga, Tenn.

Regenstein, Lewis. America the poisoned: how deadly chemicals are destroying our environment, our wildlife, ourselves and--how we can survive. Washington, D.C., Acropolis Books, 1982. 414 p.

Rogoshewski, P. J., H. Bryson, and K. Wagner. Remedial action technology for waste disposal sites. Prepared for the U.S. Environmental Protection Agency. Park Ridge, N.J., Noyes Data Corp., 1983. 497 p.

Senkan, Selim, and Nancy M. Stauffer. What to do with hazardous waste. Technology review, v. 84, Nov.-Dec. 1981: 34-47.
The authors describe the magnitude of the solid waste disposal problem and discuss various treatment and disposal methods.

Serper, Allen. Consider alternatives to landfilling for disposing of hazardous wastes. Solid wastes management, v. 24, Feb. 1981: 62, 64, 66, 163, 184.
"New technologies offer environmentally sound choices."

Suler, Dennis. Composting hazardous industrial wastes. Compost science/land utilization, v. 20, July-Aug. 1979: 25-27.
Research indicates that composting can degrade recalcitrant compounds found in such toxic materials as "crankcase oil, polychlorinated biphenyls, crude oil, TNT, pesticide residues and refinery sludge."

Sun, Marjorie. Missouri's costly dioxin lesson. Science, v. 219, Jan. 28, 1983: 367-369.
For twelve years State and Federal officials allowed the activities of a waste oil hauler to go unchecked with the result that "over 100 sites in the state are now contaminated with the highly toxic chemical dioxin."

Tallmer, Matt. Hooker's other Love Canals: chemical dumping as a corporate way of life. Progressive, v. 45, Nov. 1981: 35-42.

Charges the Hooker Chemical Company with irresponsible dumping of hazardous substances at their plants in California and New York State.

Thomas, Kenny, Betty Brink, and Ginny Thomas. "Get in there and fight": taking on toxic dumping. Southern exposure, v. 9, fall 1981: 26-47.

Describes public reaction to four cases of hazardous waste dumping. Emphasizes the frustration experienced by the citizens who attempted to have these conditions corrected.

Toxic and hazardous waste disposal. Edited by Robert B. Pojasek. Ann Arbor, Mich., Ann Arbor Science, 1979-1980. 4 v.

Contents.--v. 1: Processes for stabilization, solidification.--v. 2: Options for stabilization, solidification.--v. 3: Impact of legislation and implementation on disposal management practices.--v. 4: New and promising ultimate disposal options.

U.S. Congress. Office of Technology Assessment. Nonnuclear industrial hazardous wastes; classifying for hazard management. Washington [For sale by the Supt. of Docs., U.S. Govt. Print. Off.] 1981. 36 p.

Finds that a well-designed degree-of-hazard classfification system might provide a strategy for cost effective management of nonnuclear industrial hazardous waste. Concludes that a quantitative hazard classification scheme could be incorporated into the current Resource Conservation and Recovery Act program.

U.S. Environmental Protection Agency. Report of the Interagency Ad Hoc Work Group for the Chemical Waste Incinerator Ship Program. Washington, 1980. 1 v. (various pagings)

"Incineration at sea offers an environmentally acceptable and cost-effective method for destruction of many types of combusible chemical wastes."

U.S. General Accounting Office. Hazardous waste disposal methods: major problems with their use; report by the Comptroller General of the United States. [Washington] 1980. 16 p.

"CED-81-21, Nov. 19, 1980"

"Hazardous waste disposal on the land is the Nation's predominant disposal method, resulting in potentially costly future cleanup efforts and serious environmental problems. Other disposal methods (deep well injection and high temperature burning) and project development approaches (facilities established on a regional or areawide basis) offer more environmentally sound solutions that should be explored and developed."

Walker, Diane T. The public's role in hazardous waste facility siting. Professional engineer, v. 53, spring 1983: 26-28.

"Regulatory agencies, industry, and environmental groups must work together to overcome the public's 'not in my backyard' attitude on waste facility siting. While it's absurd to suggest shutting down industry, it's equally absurd to deny the public a role in hazardous waste facility siting decisions."

Who's poisoning America: corporate polluters and their victims in the chemical age. Edited by Ralph Nader, Ronald Brownstein, John Richard. San Francisco, Sierra Club Books, 1981. 369 p.

Worthy, Ward. Hazardous waste: treatment technology grows. Chemical & engineering news, v. 60, Mar. 8, 1982: 10-16.
Legislation requiring manufacturers to dispose of their harmful wastes in an environmentally acceptable way has triggered a plethora of both physical and chemical methods to treat these wastes.

Zuesse, Eric. Love Canal: the truth seeps out. Reason, v. 12, Feb. 1981: 16-33.
In defense of the Hooker Chemical Company the author declares that "hardly ever has there been a more blatant example of Big Brother successfully hiding the skeletons in his closet or of a gullible investigative reporter and a compliant major media going along with the cover-up so that a bunch of bureaucrats can pass the buck to some bewildered private interest."

B. LEGISLATION AND REGULATION

Alexander, Tom. The hazardous-waste nightmare. Fortune, v. 101, Apr. 21, 1980: 52-54, 57-58.
Criticizes the Federal Government's legislative and regulatory response to the problems of hazardous waste. Contends that the risks of hazardous waste exposure are unclear and that measures calling for zero-release of hazardous wastes are extreme. Believes it is wrong for chemical producers to be "hit with novel theories of liability simply because their pockets happen to be deeper than those of other participants in the chain of use."

Brenner, Joseph K. Liability for generators of hazardous waste: the failure of existing enforcement mechanisms. Georgetown law journal, v. 69, Apr. 1981: 1047-1081.
Note examines "the deficiencies of modern statutory and common law liability for harm caused by the improper treatment of hazardous wastes by independent contractors," and argues that "the RCRA actually creates financial incentives for generator to avoid assuming responsibility for the disposal of the wastes they produce."

Canter, Bram D. E. Hazardous waste disposal and the new State siting programs. Natural resources lawyer, v. 14, no. 3, 1982: 421-455.
Describes and compares twelve State hazardous waste disposal siting programs that have been recently enacted. Focuses on the use of special siting Boards, the exercise of override authority over local government vetoes, and measures to enhance public participation in the siting process.

Davidson, Isabelle R. An analysis of existing requirements for siting and permitting hazardous waste disposal facilities and a proposal for a more workable system. Administrative law review, v. 34, fall 1982: 533-558.

Article proposes "specific amendments to the RCRA regulations which would provide that no state would be authorized to administer the HWM [hazardous waste management] permitting program or receive federal SWM [solid waste management] assistance unless the state coordinated activities of all state and local authorities in facility establishment."

Epstein, Samuel S., Lester O. Brown, and Carl Pope. Hazardous waste in America. San Francisco, Sierra Club Books, 1982. 593 p.

Finlayson, Robert A. Should State rules be tougher than EPA's? Solid wastes management, v. 25, May 1982: 78, 80-82, 84.

Describes hazardous wastes regulation by the States under the Resource Conservation and Recovery Act. Includes a chart comparing the regulations of each State with RCRA.

Getting RCRA under control. Chemical week, v. 130, June 9, 1982: 36-40.

Discusses the EPA's implementation of the hazardous waste sections of the Resource Conservation and Recovery Act. Describes congressional attempts to tighten the regulation to include small generators of hazardous wastes and highlights the response of the chemical industry.

Grad, Frank P. A legislative history of the Comprehensive Environmental Response, Compensation and Liability ("Superfund") Act of 1980. Columbia journal of environmental law, v. 8, no. 1, 1982: 1-36.

This article focuses on the progress of H.R. 7020 in the 96th Congress, which "in name if not in substance" emerged as the Superfund Act.

Guida, Joseph F. Corporate decision making to meet EPA hazardous waste requirements. Professional engineer, v. 53, spring 1983: 15-23.

Outlines liability; the growing role of the States; enforcement prospects; negotiation strategies and non-litigation dispute resolution. Includes a short article by Marcus Sittenfield on how to conduct a hazardous waste audit.

Hall, Ridgway M., Jr. The problem of unending liability for hazardous waste management. Business lawyer, v. 38, Feb. 1983: 593-621.

Describes the legal uncertainties of the problem and concludes that it "will be with us for years to come. While future action by Congress, EPA, enforcement agencies, and the courts can ease or complicate that problem, there is much that a company engaged in the generation or handling of hazardous wastes can do to minimize this liability and reduce its risks to manageable levels."

Hanson, David J. Progress under Superfund criticized, defended. Chemical & engineering news, v. 60, June 7, 1982: 10-15.

Two years after Superfund's creation, critics complain that the quick cleanup of hazardous waste sites that Congress intended is going too slowly; EPA counters that rapid and effective action is being taken.

Hazardous waste control efforts: a frightful mess. Conservation Foundation letter, Apr. 1980: 1-8.

"Extensive government regulation--for all its drawbacks and for all the aversion to it--is essential to mitigate the dangers of hazardous waste and to alleviate public distrust and antagonism."

Hazardous wastes management. Chemical times & trends, v. 4, July 1981: 7-19, 31-33.

This series of articles includes: Federal regulation of hazardous wastes under RCRA: recent developments, by R. Flye.--A good waste management program, by D. Rausch.--What does the future hold in hazardous waste? by F. Hart.

Hazardous wastes, politics, and public policy: a comparative State analysis. Western political quarterly, v. 36, June 1983: 257-285.

"This paper explores the influence of economic, technological, and political factors upon the fifty American states' policy responses to the problem of hazardous waste regulation. . . . Previous comparative state studies suggest that economic resources are strongly related to policy outputs. . . . This study, by contrast, finds that both technological factors and political factors are strongly related to public policies enacted for the regulation of hazardous waste."

Helfrich, James C. Problems in pollution response liability under Federal law: FWPCA section 311 and the Superfund. Journal of maritime law and commerce, v. 13, July-Oct. 1982: 455-479.

Article examines the unique elements of both the Superfund Act and the FWPCA as they pertain to pollution by shipping, and discusses only issues of liability and enforcement.

Hileman, Bette. Enforcement by EPA. Environmental science & technology, v. 17, Feb. 1983: 72A-75A.

"Congressional concern about certain aspects of enforcement has led to unprecedented legal events."

Jubak, Jim, and Richard Asinof. Scapegoats and deep throats. Environmental action, v. 14, Apr. 1983: 8-14.

"By shaking up EPA, the White House hopes to hush up its own role in the scandal."

Lee, Joseph D. RCRA's State program provisions and the Tenth Amendment: coercion or cooperation? Ecology law quarterly, v. 9, no. 3, 1981: 579-598.

"RCRA may present a serious constitutional issue: the Act's attempt to encourage states to develop their own hazardous waste control programs while imposing through the EPA regulations minimum requirements for such programs may violate the sovereignty guaranteed states by the tenth amendment." This comment "considers the constitutionality of the Act's state program provisions and the EPA regulations and concludes that they do not violate the tenth amendment."

Lehman, Andrew T. Implications of the Resource Conservation and Recovery Act of 1976, Public Law 94-580. Environmental comment, Sept. 1980: 4-7.

This act marks a major shift in the role of the Federal Government toward direct involvement in solid waste management. It was passed to protect human health and to conserve material and energy resources.

Mosher, Lawrence. EPA still doesn't know the dimensions of Nation's hazardous waste problem. National journal, v. 15, Apr. 16, 1983: 796-799.
Describes "the recent political uproar over EPA." The agency's bad publicity has blurred the distinction between abandoned dumps, i.e., "superfund sites," and treatment disposal sites which are "solution sites."

----- Ruckelshaus's first mark on EPA--another $165.5 million for its budget. National journal, v. 15, June 25, 1983: 1344-1345.
"The White House had proposed a third consecutive budget cut, but congressional resistance and the new administrator have it singing a different tune."

National Conference of State Legislatures. Hazardous waste management: a survey of State laws; 1976-1980 (update). Washington, 1980. 1 v. (various pagings)

National Society of Professional Engineers. Environmental Policy Task Force. Position on hazardous waste management. Professional engineer, v. 53, spring 1983: 11-14.
Expresses the official views of the Society on "the legislation and regulations which govern the recovery, detoxification, and disposal of hazardous waste materials."

Osborne, David. Environmental deregulation. Atlantic monthly, v. 249, June 1982: 22, 26, 28-29.
Asks "How will the Reagan environmental policies ultimately affect our health?" and concludes: "Right now we stand to lose a decade of progress in the newborn science of environmental protection, and the full weight of that loss is impossible to calculate."

Quarles, John. Federal regulation of hazardous wastes: a guide to RCRA. Washington, Environmental Law Institute, 1982. 229 p.
This book is designed to "provide useful guidance to any person concerned with applying or understanding RCRA's manifold requirements." It deals with regulation, permits, standards, enforcement, liability, and possible waste treatment methods.

Rosbe, William L. RCRA and regulation of hazardous and nonhazardous solid wastes--closing the circle of environmental control. Business lawyer, v. 35, July 1980: 1519-1543.
"This paper surveys the principal RCRA requirements affecting companies handling hazardous (and, to a lesser degree, nonhazardous) industrial solid wastes, and highlights potential problems that they will encounter. It does so by applying RCRA and EPA's proposed regulations to a hypothetical example."

Schnapf, David. State hazardous waste programs under the Federal Resource Conservation and Recovery Act. Environmental law, v. 12, spring 1982: 679-743.
Examines State participation in the Federal hazardous waste regulatory program established by EPA. Reviews the history and structure of the RCRA and examines the statutory framework for State regulation of hazardous wastes. Explores the possible effects of Reagan's New Federalism on hazardous waste disposal.

Steeler, Jonathan H., and Greg H. Lazarus. Development of a State hazardous waste management system: planning, ownership options, liability and management technologies. Denver, National Conference of State Legislatures, 1979. 57 p.

"NSF/RA 790430"

"This report is the first in a series concerning the development of hazardous waste management capabilities. Economic, technical, and legal aspects of the service component of a hazardous waste management system are examined to provide information to legislators and legislative staff in these areas and to identify future needs."

U.S. Congress. House. Committee on Interstate and Foreign Commerce. Subcommittee on Transportation and Commerce. Superfund. Hearings, 96th Cong., 1st sess., on H.R. 4571, H.R. 4566, and H.R. 5290, bills to amend the Federal Water Pollution Control Act, as amended, and the Solid Waste Disposal Act, as amended, to provide a system of response, liability, and compensation for releases of oil, hazardous substances, and hazardous wastes, to establish a response and liability fund, and for other purposes. Washington, U.S. Govt. Print. Off., 1980. 693 p.

Hearings held June 19-Oct. 11, 1979.

"Serial 96-114"

U.S. Congress. Senate. Committee on Environment and Public Works. Subcommittee on Environmental Pollution. Hazardous and toxic waste disposal. Joint hearings before the Subcommittees on Environmental Pollution and Resource Protection of the Committee on Environment and Public Works, U.S. Senate, 96th Cong., 1st sess., on S. 1341 and S. 1480. Part 4. Washington, U.S. Govt. Print. Off., 1979. 854 p.

Hearings held June 20-Sept 7, 1979.

----- Implementation of the Comprehensive Environmental Response, Compensation, and Liability Act of 1981. Hearings, 97th Cong., 1st sess. July 8 and 20, 1981. Washington, U.S. Govt. Print. Off., 1981. 174 p.

"Serial no. 97-H31"

Waste management in the States. Lexington, Ky., Council of State Governments, 1982. 22 p.

Provides an overview of "the key issues and the state/federal statutes affecting the management of solid, hazardous and low-level wastes. This report was compiled from existing reports and a survey conducted by the Council of State Governments during September 1981."

Wilheim, Georgina Katherina. The regulation of hazardous waste disposal: cleaning up the Augean stables with a flood of regulations. Rutgers law review, v. 33, summer 1981: 906-972.

"Note presents an overview of the hazardous waste problem both nationwide and in New Jersey and examines the maze of applicable federal and state regulatory programs. A discussion of current state efforts to deal with hazardous waste management is also presented and some suggestions are advanced to improve the regulation of hazardous wastes."

Wolf, Sidney M. Hazardous waste trials and tribulations. Environmental law, v. 13, winter 1983: 367-491.

"This Article is about governmental and industrial mismanagement of hazardous waste and the attendant dangers to human health and the environment. Hazardous waste is widely regarded as 'our number one environmental problem,' and as with other major societal problems there has been an attempt to find a solution through federal legislation."

II. COMPENSATION OF VICTIMS

This section consists of two parts. Part A, Legal Process and Problems of Obtaining Compensation deals with obtaining compensation for damages due to toxic substances pollution and includes aspects of insurance and suggestions for legislation to provide financing for compensation. Part B Uncertainty of Scientific and Medical Evidence relates to health effects and the reliability of technical evidence in court and in the laboratory.

A. LEGAL PROCESS AND PROBLEMS OF OBTAINING COMPENSATION

Allocating the costs of hazardous waste disposal. Harvard law review, v. 94, Jan. 1981: 584-604.

"This Note surveys and compares, from a utilitarian point of view, the institutions and substantive schemes that seek to reallocate the costs of hazardous chemical wastes."

American Bar Association. Committee on Business Mangement Liability Insurance. Liability insurance against environmental damage: a status report, June 1982. Business lawyer, v. 38, Nov. 1982: 217-239.

Concludes that "whatever eventual form the RCRA regulations may take, it is a virtual certainty that the demand for insurance coverage will continue to exist because claims for damage to persons and property resulting from pollution will continue to be made. Developments to date provide encouraging evidence that insurance capacity to meet these needs will be available."

Bauer, Theodore. Love Canal: common law approaches to a modern tragedy. Environmental law, v. 11, fall 1980: 133-160.

"Beyond the environmental and aesthetic damage, there remains the inequitable distribution of economic loss and personal injury caused by such chemical waste mismanagement. This Comment suggests common law remedies available to redress such damage, especially where statutory relief is nonexistent or not retroactively available."

Charo, Robin Alta. Class actions and mass toxic torts. Columbia journal of environmental law, v. 8, no. 1, 1982: 269-307.

Comment finds that "a class action based on common questions of law and fact is most likely to gain certification in toxic tort cases. Unfortunately, jurisdictional requirements and a judge's subjective determination concerning the superiority of a class action as opposed to individual suits can present a significant obstacle."

Compensation for victims of water pollution. Prepared for the Committee on Public Works and Transportation, U.S. House of Representatives, by the Congressional Research Service of the Library of Congress. Washington, U.S. Govt. Print. Off., 1979. 372 p.

At head of title: 96th Congress, 1st session. Committee print.

Dore, Michael. The standard of civil liability for hazardous waste disposal activity: some quirks of Superfund. Notre Dame lawyer, v. 57, Dec. 1981: 260-284.

Feinberg, Deborah W. Denial of a remedy: former residents of hazardous waste sites and New York's statute of limitations. Columbia journal of environmental law, v. 8, no. 1, 1982: 161-174.

Note examines the constitutional and policy implications of New York State's statute of limitations for personal injury suits in relation to former residents of the Love Canal area who suffer from delayed effects of site-related injuries.

Fitzgerald, John M., and Martin Machowsky. Superfund II: compensating victims of hazardous substances. Federal Bar news & journal, v. 30, Apr. 1983: 194-204.

Concludes that "it will take a major congressional effort to provide a comprehensive and effective program for administrative compensation, and a herculean effort to reform statutory law to establish a new cause of action for toxic torts."

Fox, Allan M. Congress considers many plans to pay toxic-substance victims. National law journal, v. 5, July 25, 1983: 26-28.

"The issue of toxic substance 'victim' compensation is emerging as one of the most important issues before the 98th Congress. It will surely get a thorough airing, especially as the 1984 elections draw nearer."

Garrett, Theodore L. Compensating victims of toxic substances: issues concerning proposed Federal legislation. Environmental law reporter, v. 13, no. 6, 1983: 10172-10178.

Article explores "two issues concerning victim compensation legislation that have yet to be considered fully--defining the nature and extent of the problem and determining the adequacy of our legal system in compensating claimants and ensuring fairness to defendents."

Ginsberg, William R., and Lois Weiss. Common law liability for toxic torts: a phantom remedy. Hofstra law review, v. 9, spring 1981: 859-941.

Deals with the problem of hazardous waste disposal sites, especially the case of the Love Canal; with common law liability for injury arising from waste disposal sites; and with obstacles inherent in hazardous waste litigation. Offers legislative alternatives.

Holmes, Eric M. Applicability of liability insurance coverage to private pollution suits: do we insure pollution? Tennessee law review, v. 40, spring 1973: 377-397.

"The purpose of this article is to ascertain whether in private civil pollution actions insurance coverage is available."

Hourihan, James A. Insurance coverage for environmental damage claims. Forum, v. 15, spring 1980: 551-564.

Reviews "the historical treatment of pollution claims by the insurance industry and . . . examines insurance coverage issues which currently exist in environmental litigation."

Hurley-Bruno, Mary. The development of a strict liability cause of action for personal injuries resulting from hazardous waste. New England law review, v. 16, no. 3, 1980-1981: 543-571.

This Note examines possible theories upon which a cause of action might be based. It describes the environmental problems caused by hazardous waste and the difficulties entailed in managing its disposal, examines the legislation which has been enacted to address hazardous waste issues; and considers common law theories of recovery and their applicability to the hazardous waste problem.

Hurwitz, Warren J. Environmental health: an analysis of available and proposed remedies for victims of toxic waste contamination. American journal of law and medicine, v. 7, spring 1981: 61-89.

Note examines common law theories of negligence, strict liability, nuisance, and trespass; concludes that none is adequate to assure recovery to a person injured and recommends the adoption of legislation ensuring compensation of victims of toxic waste contamination.

Injuries and damages from hazardous wastes--analysis and improvement of legal remedies; a report to Congress in compliance with section 301(e) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (P.L. 96-510) by the "Superfund Section 301(e) Study Group." Washington, U.S. Govt. Print. Off. [available from NTIS] 1982. 2 v.

Printed for the use of the Senate Committee on Environment and Public Works. Now available only from NTIS, 125 13th St. NW, Room 620, Washington DC.

Part 1--The report and comments (PB-83-206052) and Part 2--Appendices (PB-83-206060)

At head of title: 97th Congress, 2d session. Committee print.

Many victims of pollution are shortchanged. Conservation Foundation letter, Jan. 1981: 1-8.

"A number of inadequate, patchwork systems are used to determine whether a person can win compensation for environmental injury, and how much."

McPheeters, Bruce B. Inactive or abandoned hazardous waste disposal sites: coping with a costly past. Southern California law review, v. 53, Sept. 1980: 1709-1745.

"This Note reviews past and current legislative and judicial activity, including the limited superfund legislation recently signed by the President, and explains the inadequacies in applying tort law and existing environmental statutes to inactive or abandoned sites. The Note briefly analyzes legislative proposals and their retroactive effect as well as differing governmental, industrial, and environmental viewpoints."

Meyer, Scott. Compensating hazardous waste victims: RCRA insurance regulations and a not so "super" fund act. Evnironmental law, v. 11, spring 1981: 689-719.

"Comment analyzes the Superfund legislation and EPA's insurance regulations as supplements to the common law compensation system. The inadequacies of the common law system are discussed to show why supplemental measures are necessary." Concludes "the Act should be amended to allow victims to recover compensation for property damage and personal injuries."

Meyers, Robert J. The viability of common law actions for pollution caused injuries and proof of facts. New York law forum, v. 18, spring 1973: 935-976.

This comment "attempts to aid in developing actions based upon the actual physical injury caused by pollution."

Milhollin, Gary. Long-term liability for environmental harm. University of Pittsburgh law review, v. 41, fall 1979: 1-26.

This article discusses the exceptional barriers to private recovery for long-term harm under the common law, the difficulty of using bonding and insurance as alternatives, and suggests as a remedy a liability fund financed by taxing the source of the risk.

Moore, W. John. Damage suits seen under amendments proposed for RCRA. Legal times, v. 6, July 25, 1983: 1, 10, 11.

"With little fanfare, Congress appears ready to adopt changes in existing hazardous waste laws that critics see as a 'back-door' effort to enact a victim compensation bill that would allow the litigation of damage claims in federal court."

Mott, Randy M. Liability for cleanup of inactive hazardous waste disposal sites. Natural resources lawyer, v. 14, no. 3, 1982: 379-419.

Article reviews the current legal basis for imposing liability for cleanup costs on the generators of hazardous wastes and on the owners and operators of disposal sites. Discusses case law which is beginning to define the dimensions of and criteria for liability in this area.

Odell, Rice. Pollution's victims rarely get compensated. Business and society review, no. 39, fall 1981: 23-28.

Describes the difficulties of obtaining compensation for Americans harmed by toxic substances. Assesses the advantages and disadvantages of industrial liability insurance.

Pfennigstorf, Werner. Environment, damages, and compensation. American Bar Foundation research journal, v. 1979, spring 1979: 347-448.

This article "reviews the existing sources of compensation in the United States: the common law of torts, federal and state statutes, and various forms of commercial insurance coverages. It shows how the rules of nuisance law have remained flexible in response to changing customs and public policies, how for a long time prevailing attitudes favored industrial development and economic growth over physical comfort, and how increasing concerns about the long-term health effects of environmental pollution have created a trend in the opposite direction."

Rea, Raymond A. Hazardous waste pollution: the need for a different statutory approach. Environmental law, v. 12, winter 1982: 442-467.

Comment concludes that "industry continues to pollute with impunity" because of the inadequacy of common law remedies and of Federal statutory controls. Recommends regional waste treatment and disposal, carefully controlled, plus legal opportunities for personal medical injury compensation and redress.

Rheingold, Paul D. Toxic substance suits: choosing the right case. National law journal, v. 4, May 24, 1982: 17-20.

Presents criteria for determining "a promising personal injury suit."

Rosenblum, Marcy S. Hazardous wastes: regulatory protection and the government as Good Samaritan. Trial, v. 18, Jan. 1982: 24-27, 73-74.

Concludes that governmental liability for compensating individuals who suffer injury from hazardous substances accidents is extremely limited, and suggests possible solutions.

Scott, Geoffrey T. G. Environmental impairment insurance. Best's review: property/casualty insurance edition, v. 82, July 1981: 60, 62, 64, 108-110.

Examines points to consider when extending environmental impairment insurance to a potential accidental or gradual polluter.

Seltzer, Mark D. Personal injury hazardous waste litigation: a proposal for tort reform. Environmental affairs law review, v. 10, no. 3, 1982-1983: 797-852.

"This article suggests a reduction of the evidentiary and substantive legal burdens that a potential plaintiff must bear in seeking compensatory relief."

Shaw, Charles Anthony. Damage claims in pollution actions brought under Section 304 of the Federal Clean Air Act. Natural resources journal, v. 13, July 1973: 511-534.

"A plaintiff seeking damages under Section 304 of the Clean Air Act should be permitted to avail himself of federal jurisdiction. This Note has discussed three methods by which this might be accomplished."

Smith, Jeffrey C., and David Godfrey-Thomas. Insurers re-enter the hazardous waste game. Best's review: property/casualty insurance edition, v. 83, June 1982: 20, 22, 24, 26.

"The uncertainty caused by EPA's year of mixed signals served no one, and certainly complicated planning by the regulated community."

Soble, Stephen M. A proposal for the administrative compensation of victims of toxic substance pollution: a model act. Harvard journal on legislation, v. 14, June 1977: 683-824.

"The Model Statute offers a comprehensive plan for compensating victims of toxic substance pollution and for encouraging the maximum level of safety in the manufacture of toxic substances."

Sokol, Michelle. Statutes of limitations and pollutant injuries: the need for a contemporary legal response to contemporary technological failure. Hofstra law review, v. 9, summer 1981: 1525-1574.

"Note examines the issue of statutes of limitations in environmental-contamination suits and illustrates that these statutes may pose significant and sometimes insurmountable obstacles to recovery in hazardous- and toxic-waste-disposal cases where private parties seek compensation for latent or progressive personal injuries." Analyzes the operation of statutes of limitations in New York, New Jersey, and California.

Stanley, Valerie J. Establishing liability for the damages from hazardous wastes: an alternative route for Love Canal plaintiffs. Catholic University law review, v. 31, winter 1982: 273-310.

Comment concludes that the United States may successfully impose liability on the manufacturers who disposed of the Love Canal wastes based on grounds of negligence under the Federal Tort Claims Act and nuisance under the Resource Conservation and Recovery Act.

Technologies and management strategies for hazardous waste control. Washington, Office of Technology Assessment, for sale by the Supt. of Docs., U.S. Govt. Print. Off. [1983] 407 p.

"Presents the analyses, findings, and conclusions of OTA's study of the Federal program for the management of nonnuclear industrial hazardous waste" and identifies four policy options "which could form the basis for an immediate and comprehensive approach to protecting human health and the environment from the dangers posed by mismanagement of hazardous waste."

Trauberman, Jeffrey. Statutory reform of "Toxic Torts": relieving legal, scientific, and economic burdens on the chemical victim. Harvard environmental law review, v. 7, no. 2, 1983: 177-296.

"This article analyzes the need for reform in the law governing harm caused by toxic substances--or 'toxic torts.' Both existing regulatory programs and private liability actions have been ineffective in controlling the costs of producing, distributing, and disposing of hazardous chemicals. The article suggests some general and specific principles for reform, which are also incorporated in a Model Statute."

U.S. Congress. House. Committee on Interstate and Foreign Commerce. Subcommittee on Transportation and Commerce. Long-term risks of hazardous waste sites: post-closure liability. Hearing, 96th Cong., 2d sess. July 25, 1980. Washington, U.S. Govt. Print. Off., 1981. 96 p.

"Serial no. 96-226"

U.S. Dept. of the Treasury. Office of Domestic Finance. Hazardous substance liability insurance, a report in compliance with section 301(b) and section 107(k)(4)(A) of P.L. 96-510. Washington, The Department [available from NTIS] 1982. 258 p.

"PB82-188236"

This study considers the adequacy and feasibility of private insurance to protect owners and operators of vessels and facilities covered by the Superfund Act.

Victim compensation: paying for the damage caused by toxic wastes. Chemical week, v. 132, Mar. 9, 1983: 32-34, 36, 38.

Discusses Federal and State initiatives to provide legislation which would finance a compensation program. "The chemical industry has a good deal at stake. The creation of a no-fault fund would mean a hefty increase in feedstock taxes. Easing restrictions in common law could put companies on the losing end of many more lawsuits. And the two moves together could result in massive payouts and skyrocketing insurance rates."

B. UNCERTAINTY OF SCIENTIFIC AND MEDICAL EVIDENCE

Assessment of health effects at chemical disposal sites: proceedings of a symposium held in New York City on June 1-2, 1981, by the Life Sciences and Public Policy Program of the Rockefeller University. William Lowrance, editor. New York, Rockefeller University; Los Altos, Calif., distributed by W. Kaufman, 1981. 166 p.

Black, Charles A. The Missouri dioxin controversy: scientific overview. Ames, Iowa, Council for Agricultural Science and Technology, 1983. 5 p. (Comments from CAST, 1983-1)

In the decision to buy out Times Beach, science was used to inflame rather than to enlighten public opinion. The extent of the danger was based upon levels of dioxin in the soil. However, the presence of dioxin in soil does not provide acceptable evidence of the existence of significant human exposure.

Brown, Michael H. Killer towns: what the government can't say about death in America. Rolling stone, no. 357, Nov. 26, 1981: 30-32, 34, 78.

Raises evidence of "cancer colonies", areas with high incidence of cancer, usually suggesting an environmental link.

Cancer incidence in the Love Canal area. Science, v. 212, June 19, 1981: 1404-1407.

"Data from the New York Cancer Registry show no evidence for higher cancer rates associated with residence near the Love Canal toxic waste burial site in comparison with the entire state outside of New York City."

Compensation for victims of toxic pollution--assessing the scientific knowledge base. Washington, National Science Foundation, 1983. 219 p.

"NSF/PRA-83007"

Contents.--Mechanisms of compensation.--Case study of 2, 4, 5-T.--Case study of DES.--Case study of NTA.--Uncertainties about toxicity and environmental effects.--Conclusions and recommended policy options.

Ember, Lois R. Uncertain science pushes Love Canal solutions to political, legal arenas. Chemical & engineering news, v. 58, Aug. 11, 1980: 22-29.

Relates the chronology of Hooker Chemical Company and the discovery of toxic chemicals at Love Canal and describes the medical research on the former residents to determine the health effects.

Epstein, Samuel S. The politics of cancer. Rev. and expanded ed. Garden City, N.Y., Anchor Press, 1979. 628 p.

----- The role of the scientist in toxic tort case preparation. Trial, v. 17, July 1981: 38-41, 52-53, 77-78.

Article concludes that "the most critical qualifications of the expert witness are objectivity and impartiality. Distinctions must be recognized between experts in areas of fact, such as exposure and diagnosis, and experts in areas of causality and inference, recognizing that in some instances, expertise may overlap. The expert should be involved in toxic tort litigation at the earliest possible stage, not only to discourage proceedings when scientifically ill-founded, but also to assist in fact finding and the development of strategy."

Freedman, Tracy. Leftover lives to live. Nation, v. 232, May 23, 1981: 624-627.

Describes the psychological damage to those who live near the Love Canal chemical dump in Niagara Falls, N.Y. Says that "just as children and infants are the most sensitive to physical damage from exposure to toxic chemicals, so too do they represent the earliest evidence of the psychological and social decay inflicted on a community following a chemical-waste disaster."

Habitability of the Love Canal area: an analysis of the technical basis for the decision on the habitability of the emergency declaration area; a technical memorandum. Washington, Office of Technology Assessment, for sale by the Supt. of Docs., U.S. Govt. Print. Off., 1983. 58 p.

"OTA-TM-M-13"

"With available information it is not possible to conclude either that unsafe levels of toxic contamination exist or they do not exist in the EDA [Emergency Declaration Area]. The OTA analysis does not support an interpretation of the DHHS [Dept. of Health and Human Resources] decision that would lead to immediate and complete rehabilitation of the EDA."

Josephson, Julian. Exposure to chemical waste sites. Environmental science & technology, v. 17, July 1983: 286A-289A.

"Scientific and legal experts are trying to resolve many problems in determining and monitoring health effects and in devising ways of compensating those who might have been injured."

Kross, Robert D., and Stanley C. Lewis. Environmental analysis--are we becoming too sensitive? Environmental forum, v. 1, Mar. 1983: 15-19.

"Do our politically-appointed agency heads, and their scientific advisory committees, have a sufficient understanding of the weak toxicological basis for many of our regulations? . . . Perhaps the time is ripe for a re-evaluation of approach and philosophy in establishing levels of safety with greater regard to advancing biological knowledge to match already-available chemichal technology."

Kuster, Bradford W. Toxic substance contamination: the risk-benefit approach to causation analysis. University of Michigan journal of law reform, v. 14, fall 1980: 53-70.

The residents of Hemlock, Michigan "allege that reinjection wells used for disposal of by-products of chemical manufacture have caused contamination of their well-water. The people in the area have suffered considerable health effects, including miscarriages, tumors, and nervous system disorders. State authorities have concluded, however, that insufficient evidence exists to establish a causal link between the complaints and private well water."

Maugh, Thomas H., II. Health effects of exposure to toxic wastes. Science, v. 215, Jan. 29, 1982: 490-493; Feb. 5: 643-647.

This two-part series first addresses the question "Just how hazardous are dumps?" and then, in "Biological markers for chemical exposure," suggests that alterations in chromosomes indicate exposure but that long term studies will be necessary to determine the severity of effects of health.

The Risks of living near Love Canal. Science, v. 212, Aug. 27, 1982: 808-809, 811.

"Controversy and confusion follow a report that the Love Canal area is no more hazardous than areas elsewhere in Niagara Falls."

Small, Gary W., and Jonathan F. Borus. Outbreak of illness in a school chorus: toxic poisoning or mass hysteria? New England journal of medicine, v. 308, Mar. 17, 1983: 632-635.

"Mass hysteria is defined as the occurrence in a group of people of a constellation of physical symptoms suggesting an organic illness but resulting from a psychological cause . . . whenever people under stress gather together, the potential for mass hysteria exists. . . . With public alarm about enviromental pollution increasing during the past decade, attempts to find toxic causes for these epidemics have intensified."

Sun, Marjorie. Dioxin's uncertain legacy. Science, v. 219, Feb. 4, 1983: 468-469.

"Animal studies indicate dioxin's toxicity, but clinical data are lacking; this uncertainty compounds the problem of what to do with contaminated sites."

Tilevitz, Orrin E. Judicial attitudes towards legal and scientific proof of cancer causation. Columbia journal of environmental law, v. 3, spring 1977: 344-381.

Comment examines cases involving cancer alleged to be caused by some toxic substance. Discussion includes the judicial attitudes toward cancer causation and the kinds of proof of causation courts have required.

U.S. General Accounting Office. Hazardous waste sites pose investigation, evaluation, scientific, and legal problems; report by the Comptroller General of the United States. [Washington] 1981. 65 p.

"CED-81-57, Apr. 24, 1981"

"This report discusses the kind of scientific evidence necessary to determine whether or not a particular disposal site poses a significant hazard to the public's health. It also discusses the capacity to collect and substantiate the kind of evidence required to prove the presence of a hazard or the presence of a relationship between a disposal site and impaired health."

III. ANCILLARY MATERIAL

This section includes supporting material related to various aspects of the debate resolution. It looks at long term considerations of environmental preservation and degradation. Questions of ethics and values, pollution costs and risks for society, increasing controls, and economic progress are raised. In addition, there are materials on other government programs for compensating victims of slow-developing occupational diseases, and also there are several items on organized crime in the waste disposal industry.

Amoroso, Vincent. Black lung: a dark liability. Pension world, v. 14, Dec. 1978: 40-42.

Considers the financial and accounting implications of recently passed black lung legislation for coal producers and industrial coal users. Focuses particularly on the role that actuarial valuations of black lung liability can play in determining company policies.

Anderson, Dan R. Limits on liability: the Price-Anderson Act versus other laws. Journal of risk and insurance, v. 45, Dec. 1978: 651-674.

"The most significant feature of the Price-Anderson Act is the $560 million limit on liability for claims arising from a nuclear accident. . . . The analysis demonstrates that the liability limit in the Act is unique, in the degree to which it protects the nuclear industry and hinders the public's right to collect for potential damages."

Anderson, Eugene R., Irene C. Warshauer, and Adrienne M. Coffin. The Asbestos Health Hazards Compensation Act: a legislative solution to a litigation crisis. Journal of legislation, v. 10, winter 1983: 25-80.

"Experience has shown that neither the workers' compensation laws nor the courts are equipped to adequately resolve the thousands of claims arising from latent occupational diseases. Injured parties are not receiving benefits in proportion to the severity of their injuries and, with the threatened viability of some manufacturers, some have opined that there may be no recourse available in future years. A legislative solution is the only answer."

Carson, Rachel Louise. Silent spring. Boston, Houghton Mifflin, 1962. 368 p.

Compensation for pollution damage. Paris, Organization for Economic Co-operation and Development, 1981. 208 p.

Examines the experience of OECD member countries with developing compensation schemes for victims of certain types of pollution. Discusses some of the legal and economic problems associated with the establishment and administration of compensation systems.

Cunningham, Robert L. Ethics, ecology, and the rights of future generations. Modern age, v. 19, summer 1975: 260-271.

Poses the question, "What do we owe future generations?"; and answers it in terms of ecology and environmental preservation.

Economic theory and environmental law. Michigan law review, v. 79, June 1981: 1393-1419.

Article emphasizes that the future of environmental policy rests on the resolution of the conflict between "what we believe in and stand for as a community with what we want and need as a functioning economy. . . . A solution must facilitate the balancing of interests with morality." The author concludes that attempts to base environmental law on economic theory must fail.

Epstein, Richard A. The principles of environmental protection: the case of Superfund. Cato journal, v. 2, spring 1982: 9-38.

Concludes that the Government should be allowed to maintain an action for the destruction of or damage to unowned natural resources, and should operate a permit system that allows it to identify the individual responsible for the release of a chemical substance into the environment.

Epstein, Samuel S. The politics of cancer. Rev. and expanded ed. Garden City, N.Y., Anchor Press, 1979. 628 p.

Farkas, Edward J. The NIMBY syndrome. Alternatives, v. 10, fall-winter 1982: 47-50.

While government, industry, and media officials frequently state that the NIMBY (the Not-In-My-Backyard) syndrome is crippling efforts to establish waste management facilities, the author argues that in fact the waste proposals themselves have been inadequate.

Fogarty, Bill. Facing up to our hazardous waste dilemma. Professional engineer, v. 53, spring 1983: 6-10.

An outline of the problem concludes that political leaders must weigh the costs of cleanup or recycling or detoxicating against the need to protect human health and the environment as they attempt to devise a national strategy for managing hazardous wastes.

Geller, Mitchell Jed. Vicarious liability of oil refiners for contamination of unleaded gasoline under the Clean Air Act. Environmental affairs, v. 6, no. 2, 1977: 249-276.

Article discusses the EPA's attempt to hold oil refiners liable for the contamination of unleaded gasoline by mixing it with leaded gasoline. Cites two court cases which modified the EPA's imposition of strict liability standards.

Goodpaster, Kenneth E., and John B. Matthews, Jr. Can a corporation have a conscience? Harvard business review, v. 60, Jan.-Feb. 1982: 132-141.

The authors argue that a corporation can and should have a conscience. They suggest that a corporation is a morally responsible "person."

Graham, Frank. Since Silent spring. Boston, Houghton-Mifflin, 1970. 333 p.

Hapgood, Fred. Risk-benefit analysis: putting a price on life. Atlantic monthly, v. 243, Jan. 1979: 33-38.

"What's the value of a human life? According to one government agency, the price is precisely $287,175. The figure is a by-product of the new science of risk-benefit analysis, which attempts to make social policy more rational, but which also poses chilling ethical problems."

Jones, Thomas E. Toward a planetary ecological ethic. World Future Society bulletin, v. 12, Sept.-Oct. 1978: 9-19.

"Here is a philosopher's attempt to identify the components of an ethical system that could guide individuals in their efforts to attain a just and sustainable world order."

Kahn, Marcy Louise, and Eugene R. Anderson. A ten-point proposal for an asbestos superfund. Forum, v. 18, spring 1983: 395-416.

"This article suggests a ten-point proposal for federal legislation establishing an asbestos superfund which would eliminate the asbestos litigation industry and create a rational system for resolving all asbestos claims expeditiously, equitably and economically."

Lalle, Frank A. Agent Orange as a problem of law and policy. Northwestern University law review, v. 77, Mar. 1982: 48-83.

Comment outlines the Agent Orange controversy, analyzes the common law response to veterans' personal injury claims and concludes that relief will be denied under present tort theories and legislative compensation programs. Suggests legislation to correct this.

Leeson, Susan M. Philosophic implications of the ecological crisis: the authoritarian challenge to liberalism. Polity, v. 11, spring 1979: 303-318.

Views the philosophical implications of the ecological crisis "in the theoretical perspective of liberalism and its institutional expression in the American constitution and reflects on its responsibility for the failure of contemporary measures to protect the environment."

Levi, Donald R., and Bruce R. Beattie. Economics as an input in environmental law: Anderson v. Atlas Chemical Industries, Inc. Land economics, v. 52, May 1976: 235-240.

Reports on the use of economic theory in a pollution lawsuit and discusses the economic implications of liability, actual damages, punitive damages, injunctive actions, and inverse condemnation for legal cases involving pollution. Concludes that the use of an economic rationale in the Anderson case is a positive step.

Martino, Joseph P. Inheriting the Earth. Reason, v. 14, Nov. 1982: 30-36, 46.

Concludes that we must reduce "the liberty of the present inhabitants of the earth in order to enhance the material well-being of future inhabitants." Uses the example of toxic waste disposal.

Marx, Thomas G. The cost of living: life, liberty, and cost-benefit analysis. Policy review, no. 25, summer 1983: 53-58.

Examines how economists quantify the value of life in cost-benefit analysis and discusses the ethics of the concept.

McKenna, Jeremiah. The Mob moves in: testimony. Empire State report, v. 9, May 1983: 25-31.

"From a position of control in solid waste disposal organized crime is today moving to control the vital industry of toxic waste disposal."

Moore, W. John. Bankruptcy stays thwarting cleanups. Legal times, v. 5, May 9, 1983: 1, 9.

"So far, to the dismay of federal and state environmental lawyers, the courts have ruled in favor of the hazardous waste companies." The courts have ruled that government efforts to compel cleanup of toxic waste by bankrupt companies "are actually a request for a money judgement against the defendent, which is prohibited by the bankruptcy statute."

Provost, Denise. The Massachusetts Hazardous Waste Facility Siting Act: what impact on municipal power to exclude and regulate? Environmental affairs law review, v. 10, 1982-1983: 715-795.

A discussion of the constitutionality of the siting act concludes that "citizens of municipalities seeking to protect themselves from hazardous waste problems must realize that the price of really 'solving' the problem will be fewer goods at higher prices."

Research needs for: a basic science of the system of humanity and nature and appropriate technology for the future. Mark T. Brown and Howard T. Odum, editors. Gainesville, Center for Wetlands, University of Florida, 1981. 155 p.

"NSF/CEE 81090"

Describes a workshop on planning a research program that would "formally recognize the role of the natural landscape in dealing with complex issues of residuals management." Evaluating research needs for appropriate techology was found to require "a basic understanding of the system of environment and human society."

Risk assessment at hazardous waste sites; based on a symposium sponsored by the ACS Committee on Environmental Improvement at the 183rd meeting of the American Chemical Society, Las Vegas, Nevada, March-April 1982. Edited by F. A. Long and Glenn E. Schweitzer. Washington, American Chemical Society, 1982. 128 p.

Saginaw, Jane N., and Brian D. Weinstein. The Manville bankruptcy: will asbestos victims get their day in court? Trial, v. 20, Apr. 1983: 76-80, 100-101.

Contends that "by filing under Chapter 11 of the Bankruptcy Act, it is Manville's design to have all of its asbestos claims estimated and discharged pursuant to a bankruptcy plan and without a jury trial. The constitutionality of such a plan, however, is highly suspect."

Shapiro, Lynn. Black lung: a second opinion. Coal age, v. 86, Sept. 1981: 104-106, 109.

Highlights the Black Lung Benefits Act, which critics contend is overgenerous. Because Federal costs due to black lung benefits are great, more medical evidence may be required before benefits are awarded.

Simeral, William G. Public fear of chemicals defines industry agenda. Financier, v. 7, July 1983: 36-40.

"Is the chemical industry poisoning America? No, and it is unqualified nonsense even to suggest that it is. But the American public does not share this belief. . . . What we really need is a new way to deal with public-health issues involving toxic substances."

Strong, Douglas H., and Elizabeth S. Rosenfield. Ethics or expediency: an environmental question. Environmental affairs, v. 5, spring 1976: 255-270.

Discusses the development of an environmental ethic, after critically examining the Judeo-Christian and the pragmatic-utilitarian ethical systems "that have contributed to our present difficulties."

Trost, Cathy. Hooker Chemical's Michigan mess. Business and society review, no. 40, winter 1981-1982: 32-39.

Describes conflict in Montague, Michigan, between those who advocate industrial development and more jobs, and those who wish to control pollution which they see as a threat to health and natural resources.

U.S. Congress. House. Committee on Education and Labor. Subcommittee on Labor Standards. Oversight hearing on the effect of the Manville and UNR bankruptcies on compensation of asbestos victims. Hearing, 97th Congress, 2nd session. Sept. 9, 1982. Washington, U.S. Govt. Print. Off., 1983. 150 p.

U.S. Congress. House. Committee on Energy and Commerce. Subcommittee on Oversight and Investigations. Organized crime links to the waste disposal industry. Hearing, 97th Cong., 1st sess. May 28, 1981. Washington, U.S. Govt. Print. Off., 1981. 298 p.

U.S. Congress. House. Committee on Ways and Means. Subcommittee on Oversight. Problems relating to the insolvency of the black lung disability trust fund. Hearings, 97th Congress, 1st sess. July 27 and Sept. 28, 1981. Washington, U.S. Govt. Print. Off., 1981. 309 p.

U.S. Environmental Protection Agency. Environmental outlook 1980. Washington, 1980. 823 p.

"EPA-600/8-80-003"

This annual publication discusses trends in public attitudes about environmental protection and policy. It provides statistics on air and water pollution, solid and hazardous wastes, toxic substances, radiation, and energy and the environment.

U.S. General Accounting Office. Siting of hazardous waste landfills and their correlation with racial and economic status of surrounding communities; report. Washington, G.A.O., 1983. 13 p.

"GAO/RCED-83-168, June 1, 1983"

"This report provides information on the racial and economic characteristics of communities surrounding four hazardous waste landfills in three southeastern States. It also describes Federal criteria for siting landfills and provides data on public participation and how the Environmental Protection Agency's (EPA's) proposed hazardous waste facility permit changes will affect it."

Waltner, Alan. Amoco Oil Co. v. Environmental Protection Agency: common law standards limit agency rulemaking. California law review, v. 65, July 1977: 886-896.

Case note describes the D.C. Circuit Court of Appeals decision to strike down an EPA regulation holding petroleum refiners liable for lead contamination of unleaded gasoline. The gasoline was sold at retail outlets owned and directly supplied by the refineries, but run by independent operators. Criticizes the court for undermining the rulemaking authority of government agencies.

IV. BIBLIOGRAPHIES

Additional references may be found in many of the preceeding citations, as well as in the following bibliographies.

Black lung benefits program: selected references. Prepared by the Dept. of Labor Library. Washington, The Library, for sale by the Supt. of Docs., U.S. Govt. Print. Off., 1979. 28 p.

Boyle, Susan B. Siting new hazardous waste management facilities through a compensation and incentives approach: a bibliography. Chicago, Ill., CPL Bibliographies, 1983.
(CPL bibliography no. 122.)
This bibliography is scheduled for publication in August 1983.

Clark, Lenore B. Siting solid waste facilities. Washington, U.S. Environmental Protection Agency, 1978. 12 p.
"SW 722"

Fuller, Wallace H. Soil modification to minimize movement of pollutants from solid waste operations. Critical reviews in environmental control, v. 9, Mar. 1980: 213-270.

Gehr, Marilyn. Solid waste management: a selected and annotated bibliography. Monticello, Ill., 1977. 68 p. (Council of Planning Librarians. Exchange bibliography 1295)

----- Solid waste management; a selected annotated bibliography. Albany, New York State Library, Legislative Service, 1976. 3 v.

Pollution: a bibliographic overview. Prepared by Coppa & Avery Consultants. Monticello, Ill., Vance Bibliographies, 1981. 9 p. (Public administration series: bibliography P-705)

Resource recovery and waste reduction; current reports. Compiled by the Resource Recovery Division, Office of Solid Waste Management Programs. Cincinnati, U.S. Environmental Protection Agency, 1978. 22 p.

Salkin, Michael S. Solid waste disposal and financing; a bibliography. [Mississippi State, Miss., Southern Rural Development Center, 1977] 76 p. (Southern Rural Development Center. SRDC bibliography series, no. 3)

Vance, Mary. Industrial waste disposal: a bibliography. Monticello, Ill., Vance Bibliographies, 1982. 53 p. (Public administration series: bibliography P-959)

Ware, Ronald E., and Dorothy P. Mitchell. Solid waste management: abstracts from the literature, 1974-1978; hazardous waste. [Washington] U.S. Environmental Protection Agency, 1979. 336 p.

Webster, James K., and Bill Foege, Jr. The literature of hazardous wastes: another growing problem. Monticello, Ill., Vance Bibliographies, 1980. 18 p. (Public administration series: bibliography P-463)

White, Anthony G. Financial, planning, and intergovernmental aspects of hazardous waste materials handling: a selected bibliography. Monticello, Ill., Vance Bibliographies, 1982. 7 p. (Public administration series: bibliography P-1027)

CHAPTER V

HAZARDOUS WASTES:

A GUIDE TO SOURCES OF INFORMATION

Kristin M. Vajs
Library Services Division

August 31, 1983

BOOKS

This partial listing of Library of Congress subject headings may be used to identify books in library catalogs on liability and other hazardous waste issues.

SEARCH TERMS:
Hazardous wastes
Hazardous waste sites
Factory and trade waste

JOURNAL ARTICLES

Citations to journal articles and other materials about hazardous waste can be found in a number of printed indexes and online bibliographic data bases. The materials covered by the printed indexes are briefly described here and the appropriate search terms are also listed.

Online bibliographic data bases enable the researcher to locate citations to journal articles and other materials quickly by using a computer terminal to search a machine-readable file. Online data bases allow the researcher to combine search terms in ways that are impossible in a printed index or library catalog and to simultaneously search material that would be contained in printed index volumes covering several years. The availability of various indexes online is indicated in the description of the tools.

> MAGAZINE INDEX

Magazine Index provides citations to materials in over 370 popular magazines, focusing on coverage of current affairs, leisure time activities, arts, sports, and science and technology. The *Index* is available online as part of the Lockheed Dialog system.

SEARCH TERMS:
Hazardous wastes
Liability for environmental damages
Hazardous waste management industry
Hazardous substances

> PUBLIC AFFAIRS INFORMATION SERVICE BULLETIN (PAIS)

PAIS is a subject index of books, pamphlets, government publications, reports of public and private agencies, and periodical articles relating to economic and social conditions, public administration, and international relations. *PAIS* is available online as part of the Lockheed Dialog system.

SEARCH TERMS:
Hazardous wastes--Liability
Hazardous wastes
Industrial waste
Hazardous materials

> READERS' GUIDE TO PERIODICAL LITERATURE

The *Readers' Guide* is an author/subject index to periodicals of general interest published in the U.S.

SEARCH TERMS:
Insurance, pollution liability
Hazardous substances
Love Canal case
Trade waste disposal

> BUSINESS PERIODICALS INDEX

Business Periodicals Index is a subject index to articles appearing in English language business periodicals. The *Index* is issued monthly and cumulated quarterly and annually.

SEARCH TERMS:
Pollution liability
Insurance, pollution liability
Hazardous substances
Chemical plants--Waste disposal
Waste disposal companies
Waste disposal sites

LEGAL MATERIALS

Articles from law journals are especially useful for exploring the liability aspects of the hazardous waste issue.

> CURRENT LAW INDEX

Current Law Index covers over 660 law periodicals selected by an advisory board of the American Association of Law Libraries. It is published in 8 monthly issues, 3 quarterly cumulations and a single annual cumulation.

SEARCH TERMS:
Hazardous wastes
Liability for environmental damages
Hazardous waste management industry
Hazardous substances

> INDEX TO LEGAL PERIODICALS

The *Index to Legal Periodicals* is a subject and author index to legal articles, yearbooks, institutes, and reviews of works published in the U.S., Canada, and other English-speaking countries. The *Index* is published monthly, except September, with a bound cumulation each year.

SEARCH TERMS:
Pollution
Liability insurance

> LEGAL RESOURCE INDEX

Legal Resource Index includes over 600 law journals, six legal newspapers and relevant materials from the Library of Congress collection, *Magazine Index*, and *National Newspaper Index*. The *Index* is arranged in four separate sections: subject, author/title, table of cases, and table of statutes. When the *Index* is supplemented, a new cumulative microfilm is provided.

SEARCH TERMS:
Hazardous wastes
Insurance, liability--Environmental aspects
Liability for environmental damages
Hazardous waste management industry

LEGISLATIVE INFORMATION

Congressional activities on hazardous waste issues may be monitored by searching the following printed publications.

> CONGRESSIONAL RECORD

The *Congressional Record* provides an edited transcript of the activities on the floor of the House and the Senate. It is published each day Congress is in session. Subject and name indexes are published biweekly and cumulated annually.

SEARCH TERMS:
Hazardous substances
Environmental Protection Agency

> CONGRESSIONAL QUARTERLY WEEKLY REPORT

Congressional Quarterly Weekly Report provides current information on congressional activities, the progress of major bills, and background information on major policy issues. Important recent articles are indexed on the back cover of each issue. Consult this index under the heading "Environment." A quarterly and an annual index are also issued. Congressional Quarterly also publishes an annual publication which cumulates material appearing in the weekly reports during a year. This publication is entitled *CQ Almanac*. *Congressional Quarterly Weekly Report* is available online through the *NEXIS* library.

SEARCH TERMS:
Hazardous waste disposal
Environmental Protection Agency

> NATIONAL JOURNAL

National Journal provides information on important executive branch and congressional actions. In addition to the annual index, the back cover of each issue also contains a brief index to recent articles. Consult this index under the heading "Environment."

SEARCH TERMS:
Environment (Subject index)
Environmental Protection Agency (Government organizations index)

> CIS INDEX (Index to the Publications of the United States Congress)

The *CIS Index*, produced by the Congressional Information Service, abstracts all congressional publications with the exception of the *Congressional Record*.

SEARCH TERMS:
Liability and insurance
Hazardous substances
Chemicals and chemical industry

> DIGEST OF PUBLIC GENERAL BILLS AND RESOLUTIONS

The *Digest* summarizes the essential features of public bills and resolutions and changes made in them during the legislative process. The *Digest* is published during each session of Congress in two cumulative issues and a final issue at the conclusion of the session. The *Digest* has sponsor/cosponsor, identical bills, short title, and subject indexes.

SEARCH TERM: Environmental protection and conservation--Hazardous wastes

> MAJOR LEGISLATION OF THE CONGRESS

The *MLC* provides summaries of selected major legislation arranged by subject. It includes background on the issues and information on the content and status of major bills affecting that issue. The publication may be examined at a Government depository library or purchased from the Government Printing Office. Search under the heading "Environmental protection" in the table of contents.

GOVERNMENT PUBLICATIONS

> MONTHLY CATALOG OF UNITED STATES GOVERNMENT PUBLICATIONS

The *Monthly Catalog* lists documents issued by all branches of the Federal Government. The *Catalog* has monthly, semiannual, and annual indexes arranged by author, title, subject, keywords, and series/report title. The *Monthly Catalog* is available online through the Lockheed Dialog system.

SEARCH TERMS:
Headings starting with the word Hazardous (Title/Keyword Index)
Headings starting with the word Toxic
Headings starting with the word Waste

> WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS

The *Weekly Compilation of Presidential Documents* contains statements, messages, and other presidential materials released by the White House during the preceding week. The *Weekly Compilation* has weekly, quarterly, and annual indexes.

SEARCH TERM: Health and medical care--Toxic wastes

NEWSPAPER ARTICLES

The following indexes may be used to locate newspaper articles on hazardous waste and liability issues.

> NEW YORK TIMES INDEX

The *New York Times Index* provides extensive abstracts for articles appearing in the *New York Times*.

SEARCH
TERM: Waste materials and disposal

> BELL & HOWELL NEWSPAPER INDEXES

The *Bell & Howell Newspaper Indexes* list articles appearing in the *Chicago Tribune*, *Chicago Sun-Times*, *Denver Post*, *Detroit News*, *Houston Post*, *Los Angeles Times*, *New Orleans Times-Picayune*, *San Francisco Chronicle*, and *Washington Post*.

SEARCH
TERM: Hazardous materials

> NATIONAL NEWSPAPER INDEX

National Newspaper Index, produced by Information Access Corporation, is available online as part of the Lockheed data base system, and provides front-page to back-page indexing on current affairs topics in the *Christian Science Monitor*, *New York Times* and *Wall Street Journal*.

> NEXIS

The *NEXIS* online library provides access to wire service articles from the Associated Press, United Press International, and Reuters, articles from the *Washington Post* and journal articles. The journals indexed include *Newsweek* and *U.S. News & World Report*. In addition to providing citations and abstracts of the materials included in the data base, *NEXIS* makes the full text of the articles available online. *NEXIS* also provides access to the *New York Times Information Bank*, which is a current affairs data base containing citations to the *New York Times* and over sixty newspapers and journals.

> NEWSSEARCH

Newssearch is the daily update of *Magazine Index*, *National Newspaper Index*, and *Legal Resources Index* in the Lockheed data base system. It provides front-page to back-page indexing of the *Christian Science Monitor*, *Wall Street Journal*, and *New York Times*, as well as popular magazines, law journals, and legal newspapers.

ADDITIONAL SOURCES OF ENVIRONMENTAL INFORMATION

INDEXES AND BIBLIOGRAPHIC DATA BASES

Citations to journal articles and other materials about environmental issues will be found in a number of printed indexes and online bibliographic data bases.

Applied Science & Technology Index is a subject index to articles appearing in science and engineering journals. The Index is issued monthly and cumulated quarterly and annually.

Environment Abstracts, a monthly abstract journal, and its annual counterpart, Environment Index, provides information on the scientific, political, and socio-economic aspects of the environment and resources literature. It provides access to articles, books, conference papers, government reports, and monographs related to that field.

The Energy Index has author, subject, geography, source, and standard industrial classification code indexes. It is issued monthly with a cumulated yearbook issued at the end of the year. The Energy Index and Environment Abstracts are both produced by the Environment Information Center, Inc.

Pollution Abstracts organizes, summarizes, and indexes worldwide technical literature on environmental pollution. The abstracts cover air and water pollution, waste water treatment and waste management, toxicology and health, noise pollution, radiation, and environmental policies, programs, legislation, and education. The publication is issued four times a year, and includes subject and author indexes.

Environmental Periodicals Biblography is published in six issues plus a cumulative annual index. Each issue contains author and subject indexes.

Most of these indexes are available online through the Lockheed Dialog system: Environment Abstracts, called Enviroline (file 40); Energy Index, called Energyline (file 69); Environmental Periodicals Bibliography, called Environmental Bibliography (file 68); and Pollution Abstracts (file 41).

LEGISLATIVE AND LEGAL INFORMATION

The *Environmental and Energy Study Conference Weekly Bulletin* is an especially good source for monitoring the status of environmental legislation being considered by Congress.

The *Environmental Law Reporter* is a looseleaf service produced by the Bureau of National Affairs (BNA), which provides timely and comprehensive coverage of environmental law developments, including Federal and State court opinions, actions in pending cases, legislative developments, Federal agency rulemaking, and Supreme Court Actions. The *Reporter* also contains analytic comments, articles, and an annual listing of writings on environmental law and policy published during the past year in law school reviews and other legal journals. There is also a statutes binder, which contains the full text of roughly one hundred Federal statutes and international agreements concerning environmental matters.

The *Environment Reporter* is a BNA looseleaf service which presents the text of Federal and State environmental laws and regulations and discusses important legal decisions. The *Reporter* also includes a weekly current developments section which reviews proposed regulations, legal actions, and new studies.

The *International Environmental Reporter* presents the texts of treaties, bilateral agreements, and conventions concerning environmental issues. This BNA looseleaf service reprints the texts of foreign environmental laws. Like the other Bureau of National Affairs reporters cited above, it includes a current developments report.

REFERENCE BOOKS

U.S. Council on Environmental Quality. Environmental quality, 1981; 12th annual report. Washington, U.S. Govt. Print. Off., 1982. 291 p.

"Summarizes the current status of the environment and considers each major area of environmental quality in the context of its historical development as a national concern."

----- The global 2000 report to the President: entering the twenty-first century. Washington, U.S. Govt. Print. Off., 1980. 3 v.

Projects environmental, population, and natural resources trends to the year 2000.

McGraw-Hill encyclopedia of environmental science. New York, McGraw-Hill, 1974. 754 p.

Focuses on the study of the external conditions that affect and influence life including meteorology and climatology, conservation, ecology, oceanography, soil science, pollution, sewage treatment, nuclear engineering, agriculture, mining, and petroleum engineering.

ORGANIZATIONS

The following organizations were selected from the Encyclopedia of Associations and the Washington Information Directory, 1982-83 as possible sources of information on environmental issues. The descriptions of the groups' activities are taken from these sources.

Environmental Action
1346 Connecticut Ave., N.W., Suite 731
Washington, D.C. 20036
(202) 833-1845

National political lobby organization with close ties with 5000 local, state and campus ecology groups.

Environmental Defense Fund
475 Park Ave., S.
New York, N.Y. 10016
(202) 686-4191

National environmental organization operating as a team of lawyers and scientists combining their skills to end "environmental degradation."

Environmental Law Institute
1346 Connecticut Ave., N.W., Suite 600
Washington, D.C. 20036
(202) 452-9600

Purposes are: to conduct and sponsor research on environmental law and policy; to maintain a clearinghouse for information regarding environmental law; and to engage in related educational activities.

Environmental Policy Institute
317 Pennsylvania Ave., S.E.
Washington, D.C. 20003
(202) 544-2600

Public interest research and education environmental organization. Analyzes and provides information on Federal environmental and energy programs and policies, makes available reports to citizens' organizations, government agencies, and industry interest groups.

National Environmental Development Association
3 National Press Building
Washington, D.C. 20045
(202) 638-1230

Believes that: both public and private interests benefit from a reasoned credible approach to the challenges of the environmental-economic interrelationship; and private enterprise must not be the victim of the war on pollution.

Natural Resources Defense Council
122 E. 42nd Street
New York, N.Y. 10017
(212) 949-0049

Works to increase public understanding of the means by which the law may be used to protect resources.

Resources for the Future
1755 Massachusetts Ave., N.W.
Washington, D.C. 20036
(202) 328-5000

Conducts research and education in public policy issues related to conservation, use and development of natural resource, energy and environmental quality.

Two governmental bodies responsible for environmental policy are:

Council on Environmental Quality
722 Jackson Place, N.W.
Washington, D.C. 20006
(202) 395-5700

Advises the president on environmental issues and prepares an annual report to Congress on environmental quality (see Reference Books section).

Environmental Protection Agency
401 M St., S.W.
Washington, D.C. 20460
(202) 755-0344

Administers Federal environmental policies, research and regulations; provides information on many environmental subjects.

SELECTED PERIODICALS

The following periodicals frequently contain articles on environmental policy and protection issues:

- Air/Water Pollution Report (weekly)
- Chemical & Engineering News (weekly)
- Chemical Week (weekly)
- Environment (10 times a year)
- Environmental Action (10 times a year)
- Environmental Science & Technology (monthly)
- EPA Journal (bi-monthly)
- Inside E.P.A. (weekly)
- Science (weekly)

CHAPTER VI

List of Depository Libraries as of September 1982

Under provisions of Title 44 of the United States Code, certain libraries are designated depositories for Government publications. Through them Federal Government documents are made available to residents of every State, District of Columbia, Guam, Puerto Rico, and the Virgin Islands. Distribution to the libraries is made by the Office of the Superintendent of Documents.

It is sometimes impossible to obtain desired publications by purchase from the Superintendent of Documents. Stocks may have been exhausted or the document may be permanently out of print. In these instances the depositories render an invaluable service by keeping such publications permanently available. Every Government publication cannot be consulted at all depository libraries. Designated Regional Depositories are required to receive and retain one copy of all Government publications made available to depository libraries either in printed or microfacsimile form. All other libraries are allowed to select the classes of publications best suited to the interests of their particular clientele.

The following list shows the location, the name of the library, the year the library became a depository, and the administrative control number assigned to each.

ALABAMA

		Depository No.
Alexander City	Alexander City State Junior College, Thomas D. Russell Library (1967)	0009A
Auburn	Auburn University, Ralph Brown Draughon Library (1907)	0002
Birmingham	Birmingham Public Library (1895)	0015
	Birmingham Southern College Library (1932)	0006
	Jefferson State Junior College, James B. Allen Library (1970)	0015A
	Miles College, C.A. Kirkendoll Learning Resource Center (1980)	0006B
	Samford University Library (1884)	0005
Enterprise	Enterprise State Junior College, Learning Resource Center (1967)	0009B
Fayette	Brewer State Junior College, Learning Resource Center Library (1979)	0013A
Florence	University of North Alabama, Collier Library (1932)	0014
Gadsden	Gadsden Public Library (1963)	0007A
Huntsville	University of Alabama at Huntsville Library (1964)	0008A
Jacksonville	Jacksonville State University Library (1929)	0010
Mobile	Mobile Public Library (1963)	0006A
	Spring Hill College, Thomas Byrne Memorial Library (1937)	0007
	University of South Alabama Library (1968)	0007B
Montgomery	Alabama State Department of Archives and History Library (1884)	0008
	Alabama Supreme Court and State Law Library (1884)	0001
	Auburn University at Montgomery Library (1971)—REGIONAL	0008B
	Maxwell Air Force Base, Air University Library (1963)	1013
Normal	Alabama Agricultural and Mechanical College, Drake Memorial Learning Resource Center (1963)	0009
Troy	Troy State University Library (1963)	0005A
Tuskegee Institute	Tuskegee Institute, Hollis Burke Frissell Library (1907)	0003
University	University of Alabama Library (1860)—REGIONAL	0012
	University of Alabama, School of Law Library (1967)	0012A

ALASKA

Anchorage	Alaska Supreme Court Library (1973)	0016A
	Anchorage Municipal Libraries, Z.J. Loussac Public Library (1978)	0018A
	Interior Department, Alaska Resources Library (1981)	1051
	University of Alaska at Anchorage Library (1961)	0019
Fairbanks	University of Alaska, Elmer E. Rasmuson Library (1922)	0017
Juneau	Alaska State Library (1900)	0016
	University of Alaska-Juneau Library (1981)	0020A
Ketchikan	Ketchikan Community College Library (1970)	0018

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LIST OF DEPOSITORY LIBRARIES

ARIZONA

		Depository No.
Coolidge	Central Arizona College, Instructional Materials Center (1973)	0022A
Flagstaff	Northern Arizona University Library (1937)	0024
Phoenix	Department of Library, Archives, and Public Records (unknown)—REGIONAL	0022
	Grand Canyon College, Fleming Library (1978)	0024A
	Phoenix Public Library (1917)	0026
Prescott	Yavapai College Library (1976)	0027B
Tempe	Arizona State University, College of Law Library (1977)	0026A
	Arizona State University Library (1944)	0025
Thatcher	Eastern Arizona College Library (1963)	0021
Tucson	Tucson Public Library (1970)	0027A
	University of Arizona Library (1907)—REGIONAL	0023
Yuma	Yuma City-County Library (1963)	0027

ARKANSAS

Arkadelphia	Ouachita Baptist University, Riley Library (1963)	0032A
Batesville	Arkansas College Library (1963)	0037A
Clarksville	College of the Ozarks, Dobson Memorial Library (1925)	0031
Conway	Hendrix College, O.C. Bailey Library (1903)	0037
Fayetteville	University of Arkansas Libraries (1907)	0029
	University of Arkansas, School of Law Library (1978)	0036A
Little Rock	Arkansas State Library (1978)—REGIONAL	0036B
	Arkansas Supreme Court Library (1962)	0028
	Little Rock Public Library (1953)	0035
	University of Arkansas at Little Rock Library (1973)	0029A
	University of Arkansas at Little Rock, Law Library (1979)	0038A
Magnolia	Southern Arkansas University, Magale Library (1956)	0036
Monticello	University of Arkansas at Monticello Library (1956)	0038
Pine Bluff	University of Arkansas at Pine Bluff, Watson Memorial Library (1976)	0028A
Russellville	Arkansas Tech University, Tomlinson Library (1925)	0032
Searcy	Harding University, Beaumont Memorial Library (1963)	0035A
State University	Arkansas State University, Dean B. Ellis Library (1913)	0033
Walnut Ridge	Southern Baptist College, Felix Goodson Library (1967)	0033A

CALIFORNIA

Anaheim	Anaheim Public Library (1963)	0065C
Arcadia	Arcadia Public Library (1975)	0042B
Arcata	Humboldt State University Library (1963)	0044A
Bakersfield	California State College-Bakersfield Library (1974)	0043B
	Kern County, Beale Memorial Library (1943)	0053
Berkeley	University of California, General Library (1907)	0041
	University of California, Law Library (1963)	0050A
Carson	California State University, Dominguez Hills Educational Resource Center (1973)	0048B
	Carson Regional Library (1973)	0048A
Chico	California State University at Chico Library (1962)	0045B
Claremont	Claremont Colleges' Libraries, Honnold Library (1913)	0055
Coalinga	West Hills Community College Library (1978)	0046B
Compton	Compton Library (1972)	0043A
Culver City	Culver City Library (1966)	0040A
Davis	University of California, Shields Library (1953)	0045A
	University of California at Davis, Law Library (1972)	0047B
Downey	Downey City Library (1963)	0041A
Fresno	California State University, Fresno, Henry Madden Library (1962)	0052A
	Fresno County Free Library (1920)	0052
Fullerton	California State University at Fullerton Library (1963)	0065A
Garden Grove	Garden Grove Regional Library (1963)	0064B

SEPTEMBER 1982

		Depository No.
Gardena	Gardena Public Library (1966)	0052B
Hayward	California State University at Hayward Library (1963)	0051B
Huntington Park	Huntington Park Library, San Antonio Region (1970)	0041B
Inglewood	Inglewood Public Library (1963)	0059B
Irvine	University of California at Irvine, General Library (1963)	0065D
La Jolla	University of California-San Diego, University Library (1963)	0066B
Lakewood	Angelo Iacoboni Public Library (1970)	0064D
Lancaster	Lancaster Regional Library (1967)	0058B
La Verne	University of La Verne, College of Law Library (1979)	0057B
Long Beach	California State University at Long Beach Library (1962)	0061A
	Long Beach Public Library (1933)	0061
Los Angeles	California State University at Los Angeles, John F. Kennedy Memorial Library (1956)	0062
	Los Angeles County Law Library (1963)	0057A
	Los Angeles Public Library (1891)	0057
	Loyola Marymount University, Charles Von der Ahe Library (1933)	0059
	Loyola Law School, Law Library (1979)	0060C
	Occidental College Library (1941)	0056
	Pepperdine University Library (1963)	0059A
	Southwestern University, School of Law Library (1975)	0050B
	U.S. Court of Appeals, Ninth Circuit Library (1981)	1052
	University of California at Los Angeles, Research Library (1932)	0043
	University of California, Los Angeles, Law Library (1958)	0058A
	University of Southern California Library (1933)	0058
	University of Southern California, Law Center Library (1978)	0061B
	Whittier College, School of Law Library (1978)	0049B
Menlo Park	Interior Department, Geological Survey Library (1962)	1006
Montebello	Montebello Library (1966)	0053B
Monterey	U.S. Naval Postgraduate School, Dudley Knox Library (1963)	1011
Monterey Park	Bruggemeyer Memorial Library (1964)	0062A
Northridge	California State University at Northridge, Oviatt Library (1956)	0063A
Norwalk	Norwalk Public Library (1973)	0053D
Oakland	Mills College Library (1966)	0060A
	Oakland Public Library (1923)	0050
Ontario	Ontario City Library (1974)	0055C
Palm Springs	Palm Springs Public Library (1980)	0061C
Pasadena	California Institute of Technology, Millikan Memorial Library (1933)	0063
	Pasadena Public Library (1963)	0063B
Pleasant Hill	Contra Costa County Library (1964)	0049A
Redding	Shasta County Library (1956)	0045
Redlands	University of Redlands, Armacost Library (1933)	0064
Redwood City	Redwood City Public Library (1966)	0047A
Reseda	West Valley Regional Branch Library (1966)	0063C
Richmond	Richmond Public Library (1943)	0049
Riverside	Riverside Public Library (1947)	0065
	University of California at Riverside Library (1963)	0065B
Sacramento	California State Library (1895)—REGIONAL	0040
	California State University at Sacramento Library (1963)	0055A
	Sacramento County Law Library (1963)	0055B
	Sacramento Public Library (1880)	0042
	University of the Pacific, McGeorge School of Law Library (1978)	0060B
San Bernadino	San Bernadino County Library (1964)	0064C
San Diego	San Diego County Law Library (1973)	0063D
	San Diego County Library (1966)	0066C
	San Diego Public Library (1895)	0066
	San Diego State University Library (1962)	0066A
	University of San Diego, Kratter Law Library (1967)	0066D
San Francisco	California Supreme Court Library (1979)	0040C
	Golden Gate University, School of Law Library (1979)	0062C
	Hastings College of Law Library (1972)	0040B
	Mechanics' Institute Library (1889)	0047
	San Francisco Public Library (1889)	0048
	San Francisco State University Library (1955)	0044

LIST OF DEPOSITORY LIBRARIES

		Depository No.
	U.S. Court of Appeals, Ninth Circuit Library (1971)	1027
	University of San Francisco, Richard A. Gleeson Library (1963)	0044C
San Jose	San Jose State University Library (1962)	0051A
San Leandro	San Leandro Community Library Center (1961)	0060
San Luis Obispo	California Polytechnic State University Library (1969)	0056D
San Rafael	Marin County Free Library (1975)	0044D
Santa Ana	Orange County Law Library (1975)	0042C
	Santa Ana Public Library (1959)	0064A
Santa Barbara	University of Claifornia at Santa Barbara Library (1960)	0054A
Santa Clara	University of Santa Clara, Orradre Library (1963)	0051C
Santa Cruz	University of California at Santa Cruz, McHenry Library (1963)	0056A
Santa Rosa	Sonoma County Library (1896)	0044B
Stanford	Stanford University Library (1895)	0051
	Stanford University, Robert Crown Law Library (1978)	0062B
Stockton	Public Library of Stockton and San Joaquin County(1884)	0046
Thousand Oaks	California Lutheran College Library (1964)	0054B
Torrance	Torrance Civic Center Library (1969)	0052C
Turlock	California State College, Stanislaus Library (1964)	0046A
Valencia	Valencia Regional Library (1972)	0058C
Vallejo	Solano County, John F. Kennedy Library (1982)	0046C
Ventura	Ventura County Library Services Agency (1975)	0054C
Visalia	Tulare County Free Library (1967)	0053C
Walnut	Mount San Antonio College Library (1966)	0056B
West Covina	West Covina Library (1966)	0056C
Whittier	Whittier College Library, Wardman Library (1963)	0053A

CANAL ZONE

Balboa Heights	Panama Canal Commission (1963)	1004

COLORADO

Alamosa	Adams State College, Learning Resources Center (1963)	0073A
Boulder	University of Colorado at Boulder Library (1879)—REGIONAL	0069
Colorado Springs	Colorado Collge, Tutt Library (1880)	0070
	University of Colorado Springs Library (1974)	0068B
Denver	Auraria Library (1978)	0069B
	Colorado State Library (unknown)	0067
	Colorado Spureme Court Library (1978)	0067B
	Denver Public Library (1884)—REGIONAL	0071
	Interior Department, Water and Power Resources Service Library (1962)	1002
	Regis College, Dayton Memorial Library (1915)	0071B
	U.S. Court of Appeals, Tenth Circuit Library (1973)	0068A
	University of Denver, Penrose Library (1909)	0071A
	University of Denver, School of Law Library (1978)	0072B
Fort Collins	Colorado State University Libraries (1907)	0068
Golden	Colorado School of Mines, Arthur Lakes Library (1939)	0072
Grand Junction	Mesa County Public Library (1975)	0070B
Greeley	University of Northerp Colorado Library (1966)	0070A
Gunnison	Western State College, Leslie J. Savage Library (1932)	0074
La Junta	Otero Junior College, Wheeler Library (1963)	0069A
Lakewood	Jefferson County Public Library, Lakewood Library (1968)	0072A
Pueblo	Pueblo Library District (1893)	0073
	University of Southern Colorado Library (1965)	0074A
USAF Academy	U.S. Air Force Academy Library (1956)	0067A

CONNECTICUT

Bridgeport	Bridgeport Public Library (1884)	0083
	University of Bridgeport, School of Law Library (1979)	0080A

		Depository No
Danbury	Western Connecticut State College Library (1967)	0084B
Danielson	Quinebaug Valley Community College Library (1975)	0079A
Enfield	Enfield Central Library (1967)	0084
Hartford	Connecticut State Library (unknown)—REGIONAL	0075
	Hartford Public Library (1945)	0085
	Trinity College Library (1895)	0080
Middletown	Wesleyan University, Olin Library (1906)	0078
Mystic	Mystic Seaport Museum, Inc., G.W. Blunt White Library (1964)	0081A
New Britain	Central Connecticut State College Library (1973)	0084A
New Haven	Southern Connecticut State College, Hilton C. Buley Library (1968)	0082A
	Yale Law Library (1981)	0076A
	Yale University Library (1859)	0082
New London	Connecticut College Library (1926)	0081
	U.S. Coast Guard Academy Library (1939)	0076
Stamford	The Ferguson Library (1973)	0083A
Storrs	University of Connecticut Library (1907)	0077
Waterbury	Post College, Traurig Library (1977)	0085A
	Silas Bronson Public Library (1869)	0079
West Hartford	University of Connecticut, School of Law Library (1978)	0077A
West Haven	University of New Haven, Peterson Library (1971)	0078A

DELAWARE

Dover	Delaware State College, William C. Jason Library (1962)	0088
	State Law Library in Kent County (unknown)	0086
Georgetown	Delaware Technical and Community College Library (1968)	0089A
	Sussex County Law Library (1976)	0086A
Newark	University of Delaware Library (1907)	0087
Wilmington	Delaware Law School Library (1976)	0088A
	New Castle County Law Library (1974)	0090

DISTRICT OF COLUMBIA

Washington	Administrative Conference of U.S. Library (1977)	1042
	Advisory Commission on Intergovernmental Relations Library (1972)	1029
	Army Department Library (1969)	1023
	Catholic University of America, R. J. White Law Library (1979)	0093B
	Civil Aeronautics Board Library (1974)	1035
	Commerce Department Library (1955)	0101A
	District of Columbia Court of Appeals Library (1981)	0099A
	District of Columbia Public Library (1943)	0100
	Energy Department Library (1963)	1014
	Executive Office of the President, Office of Administration Library (1965)	1015
	Federal Deposit Insurance Corporation Library (1972)	1028
	Federal Election Commission Library (1975)	1037
	Federal Labor Relations Authority, Law Library (1982)	1054
	Federal Mine Safety and Health Review Commission Library (1979)	1049
	Federal Reserve System, Board of Governors, Research Library (1978)	1044
	Federal Reserve System, Law Library (1976)	1040
	General Accounting Office Library (1974)	1034
	General Services Administration Library (1975)	1036
	Georgetown University, Law Center, Fred O. Dennis Law Library (1978)	0093A
	Georgetown University Library (1969)	0100A
	George Washington University, Jacob Burns Law Library (1978)	0092A
	Health and Human Service Department Library (1954)	0101
	Housing and Urban Development Department Library (1969)	1024
	Interior Department, Natural Resources Library (1895)	0093
	Justice Department, Main Library (1895)	0094
	Labor Department Library (1976)	1038
	Library of Congress, Congressional Research Service (1978)	1047
	Library of Congress, Serial and Government Publications, Documents Unit (1977)	1043
	Merit Systems Protection Board Library (1979)	1048

LIST OF DEPOSITORY LIBRARIES

	Depository No.
National Defense University Library (1895)	0099
Navy Department Library (1895)	0095
Office of Personnel Management Library (1963)	1005
State Department Law Library (1966)	1016
State Department Library (1895)	0097
Transportation Department, National Highway Traffic Safety Administration Library (1968)	1019
Treasury Department Library (1895)	0098
U.S. Court of Appeals, Judges' Library (1975)	0100D
U.S. Postal Service Library (1895)	0096
U.S. Senate Library (1979)	0094A
U.S. Supreme Court Library (1979)	1045
University of the District of Columbia Library (1970)	0100B
Veterans' Administration, Central Office Library (1967)	1017

FLORIDA

Boca Raton	Florida Atlantic University, S. E. Wimberly Library (1963)	0107B
Clearwater	Clearwater Public Library (1972)	0102B
Coral Gables	University of Miami Library (1939)	0110
Daytona Beach	Volusia County Library Center (1963)	0104B
De Land	Stetson University, duPont-Ball Library (1887)	0105
Fort Lauderdale	Broward County Library (1967)	0107D
	Nova University Law Library (1967)	0107C
Fort Pierce	Indian River Community College Library (1975)	0112B
Gainesville	University of Florida, College of Law Library (1978)	0110B
	University of Florida Libraries (1907)—REGIONAL	0103
Jacksonville	Haydon Burns Library (1914)	0106
	Jacksonville University, Swisher Library (1962)	0106A
	University of North Florida, Thomas G. Carpenter Library (1972)	0106D
Lakeland	Lakeland Public Library (1928)	0107
Leesburg	Lake-Sumter Community College Library (1963)	0104A
Melbourne	Florida Institute of Technology Library (1963)	0111A
Miami	Florida International University Library, Tamiami Campus (1970)	0105B
	Miami Public Library (1952)	0108
North Miami	Florida International University, North Miami Campus Library (1977)	0109B
Opa Locka	Biscayne College Library (1966)	0106B
Orlando	University of Central Florida Library (1966)	0105A
Palatka	Saint Johns River Community College Library (1963)	0112
Pensacola	University of West Florida, John C. Pace Library (1966)	0103A
Port Charlotte	Charlotte County Library System (1973)	0112A
Saint Petersburg	Saint Petersburg Public Library (1965)	0102A
	Stetson University College of Law, Charles A. Dana Library (1975)	0102C
Sarasota	Selby Public Library (1970)	0109A
Tallahassee	Florida Agricultural and Mechanical University, Coleman Learning Resources Center (1936)	0104
	Florida State University, College of Law Library (1978)	0111B
	Florida State University, Robert M. Strozier Library (1941)	0109
	Florida Supreme Court Library (1974)	0110A
	State Library of Florida (1929)	0102
Tampa	Tampa-Hillsborough County Public Library (1965)	0108C
	University of South Florida Library (1962)	0108B
	University of Tampa, Merl Kelce Library (1953)	0108A
Winter Park	Rollins College, Mills Memorial Library (1909)	0111

GEORGIA

Albany	Albany-Dougherty Public Library (1964)	0119
Americus	Georgia Southwestern College, James Earl Carter Library (1966)	0120
Athens	University of Georgia Libraries (1907)—REGIONAL	0114
	University of Georgia, School of Law Library (1979)	0116A

		Depository No.
Atlanta	Atlanta Public Library (1880)	0122
	Atlanta University Center, Robert W. Woodruff Library (1962)	0122A
	Emory University, Robert W. Woodruff Library (1928)	0116
	Emory University, School of Law Library (1968)	0121A
	Georgia Institute of Technology, Price Gilbert Memorial Library (1963)	0122B
	Georgia State Library (unknown)	0113
	Georgia State University, William Russell Pullen Library (1970)	0114A
	U.S. Court of Appeals, Fifth Circuit Library (1980)	1090
Augusta	Augusta College, Reese Library (1962)	0127
Brunswick	Brunswick Glynn County Regional Library (1965)	0125A
Carrollton	West Georgia College, Irvine Sullivan Ingram Library (1962)	0121
Columbus	Columbus College, Simon Schwob Memorial Library (1975)	0120A
Dahlonega	North Georgia College, Stewart Library (1939)	0126
Dalton	Dalton Junior College Library (1978)	0126B
Decatur	DeKalb Community College, South Campus Learning Resources Center (1973)	0121B
Macon	Mercer University, Stetson Memorial Library (1964)	0123A
	Mercer University, Walter F. George School of Law Library (1978)	0113A
Marietta	Kennesaw College Memorial Library (1968)	0124
Milledgeville	Georgia College at Milledgeville, Ina Dillard Russell Library (1950)	0123
Mount Berry	Berry College, Memorial Library (1970)	0124A
Savannah	Chatham-Effingham-Liberty Regional Library (1857)	0118
Statesboro	Georgia Southern College, Rosenwald Library (1939)	0117
Valdosta	Valdosta State College Library (1956)	0125

GUAM

Agana	Nieves M. Flores Memorial Library (1962)	0132
Mangilao	University of Guam, Robert F. Kennedy Memorial Library (1978)	0132A

HAWAII

Hilo	University of Hawaii at Hilo Library (1962)	0130
Honolulu	Hawaii Medical Library Inc. (1968)	0128A
	Hawaii State Library (1929)	0128
	Hawaii Supreme Court Law Library (1973)	0129A
	Municipal Reference & Records Center (1965)	0131A
	University of Hawaii Library (1907)—REGIONAL	0129
	University of Hawaii, School of Law Library (1978)	0129B
Laie	Brigham Young University, Joseph F. Smith Library (1964)	0133
Lihue	Kauai Regional Library (1967)	0133A
Pearl City	Leeward Community College Library (1967)	0130B
Wailuku	Maui Public Library (1962)	0131

IDAHO

Boise	Boise Public Library and Information Center (1929)	0139
	Boise State University Library (1966)	0136A
	Idaho State Law Library (unknown)	0134
	Idaho State Library (1971)	0135A
Caldwell	College of Idaho, Terteling Library (1930)	0138
Moscow	University of Idaho, College of Law Library (1978)	0134A
	University of Idaho Library (1907)—REGIONAL	0135
Pocatello	Idaho State University Library (1908)	0137
Rexburg	Ricks College, David O. McKay Library (1946)	0136
Twin Falls	College of Southern Idaho Library (1970)	0137A

ILLINOIS

Bloomington	Illinois Wesleyan University Library (1964)	0161A
Carbondale	Southern Illinois University, Morris Library (1932)	0160
	Southern Illinois University, School of Law Library (1978)	0147B
Carlinville	Blackburn College, Lumpkin Library (1954)	0164

LIST OF DEPOSITORY LIBRARIES

		Depository No.
Carterville	Shawnee Library System (1971)	0168A
Champaign	University of Illinois Law Library (1965)	0165A
Charleston	Eastern Illinois University, Booth Library (1962)	0166
Chicago	Chicago Public Library (1876)	0144
	Chicago State University, Paul and Emily Douglas Library (1954)	0146
	DePaul University Law Library (1979)	0158B
	Field Museum of Natural History Library (1963)	0142A
	Illinois Institute of Technology, Chicago-Kent College of Law Library (1978)	0160A
	Illinois Institute of Technology, Kemper Library (1982)	0146A
	John Crerar Library (1909)	0144A
	John Marshall Law School Library (1981)	0157A
	Loyola University of Chicago, E. M. Cudahy Memorial Library (1966)	0152A
	Loyola University, School of Law Library (1979)	0158A
	Northeastern Illinois University Library (1961)	0163A
	Northwestern University, School of Law Library (1978)	0147A
	University of Chicago, Law Library (1964)	0145A
	University of Chicago Library (1897)	0145
	University of Illinois at Chicago Circle Library (1957)	0150
	William J. Campbell Library of the U.S. Courts (1979)	0155A
Decatur	Decatur Public Library (1954)	0165
DeKalb	Northern Illinois University, Founders' Memorial Library (1960)	0154A
Des Plaines	Oakton Community College, Learning Resource Center (1976)	0141A
Edwardsville	Southern Illinois University, Lovejoy Memorial Library (1959)	0167
Elsah	Principia College, Marshall Brooks Library (1957)	0169A
Evanston	Northwestern University Library (1876)	0153
Freeport	Freeport Public Library (1905)	0156
Galesburg	Galesburg Public Library (1896)	0158
Glen Ellyn	Northern Illinois University, College of Law Library (1978)	0160B
Jacksonville	MacMurray College, Henry Pfeiffer Library (1957)	0169
Kankakee	Olivet Nazarene College, Benner Library and Resource Center (1946)	0161
Lake Forest	Lake Forest College, Donnelley Library (1962)	0153A
Lebanon	McKendree College, Holman Library (1968)	0167A
Lisle	Illinois Benedictine College, Theodore Lownik Library (1911)	0154
Macomb	Western Illinois University Library (1962)	0169B
Moline	Black Hawk College, Learning Resources Center (1970)	0160
Monmouth	Monmouth College, Hewes Library (1860)	0157
Mount Carmel	Wabash Valley College Library (1975)	0166A
Mt. Prospect	Mt. Prospect Public Library (1977)	0164A
Normal	Illinois State University, Milner Library (1877)	0143
Oak Park	Oak Park Public Library (1963)	0163
Oglesby	Illinois Valley Community College, Jacobs Memorial Library (1976)	0143A
Palos Hills	Moraine Valley Community College Library (1972)	0147
Park Forest South	Governors' State University Library (1974)	0161B
Peoria	Bradley University, Cullom-Davis Library (1963)	0159A
	Peoria Public Library (1883)	0159
River Forest	Rosary College, Rebecca Crown Library (1966)	0163B
Rockford	Rockford Public Library (unknown)	0152
Romeoville	Lewis University Library (1952)	0142
Springfield	Illinois State Library (unknown)—REGIONAL	0140
Streamwood	Popular Creek Public Library District (1980)	0164B
Urbana	University of Illinois Library (1907)	0141
Wheaton	Wheaton College Library (1964)	0154B
Woodstock	Woodstock Public Library (1963)	0153B

INDIANA

Anderson	Anderson College, Charles E. Wilson Library (1959)	0178
Bloomington	Indiana University Law Library (1978)	0177B
	Indiana University (1881)	0173
Crawfordsville	Wabash College, Lilly Library (1906)	0179
Evansville	Evansville and Vanderburgh County Public Library (1928)	0181
	Indiana State University at Evansville Library (1969)	0182A

		Depository No.
Fort Wayne	Allen County Public Library (1896)	0177
	Indiana University-Purdue University at Fort Wayne, Helmke Library (1965)	0177A
Franklin	Franklin College Library (1976)	0172B
Gary	Gary Public Library (1943)	0174
	Indiana University, Northwest Campus Library (1966)	0172A
Greencastle	De Pauw University, Roy O. West Library (1879)	0172
Hammond	Hammond Public Library (1964)	0174A
Hanover	Hanover College, Duggan Library (1892)	0182
Huntington	Huntington College, Loew Alumni Library (1964)	0178A
Indianapolis	Butler University, Irwin Library (1965)	0184A
	Indianapolis-Marion County Public Library (1906)	0184
	Indiana State Library (unknown)—REGIONAL	0170
	Indiana Supreme Court Law Library (1975)	0171A
	Indiana University, School of Law Library (1967)	0184B
	Indiana University-Purdue University at Indianapolis Library (1979)	0183B
Kokomo	Indiana University at Kokomo, Learning Resource Center (1969)	0173A
Lafayette	Purdue University Library and Audio-Visual Center (1907)	0171
Muncie	Ball State University Library (1959)	0180
	Muncie Public Library (1906)	0183A
New Albany	Indiana University, Southeastern Campus Library (1965)	0181A
Notre Dame	University of Notre Dame, Memorial Library (1883)	0176
Rensselaer	St. Joseph's College Library (1964)	0175A
Richmond	Earlham College, Lilly Library (1964)	0180A
	Morrison-Reeves Library (1906)	0183
South Bend	Indiana University at South Bend Library (1965)	0176A
Terre Haute	Indiana State University, Cunningham Memorial Library (1906)	0179A
Valparaiso	Valparaiso University, Moellering Memorial Library (1930)	0175
	Valparaiso University, Wesemann Hall Law Library (1978)	0171B

IOWA

Ames	Iowa State University Library (1907)	0186
Cedar Falls	University of Northern Iowa Library (1946)	0191
Council Bluffs	Free Public Library (1885)	0195
	Iowa Western Community College, Hoover Library (1972)	0195A
Davenport	Davenport Public Library (1973)	0192B
Des Moines	Des Moines Public Library (1888)	0193
	Drake University, Cowles Library (1946)	0194
	Drake University, Law Library (1972)	0193A
	State Library of Iowa (unknown)	0185
Dubuque	Carnegie-Stout Public Library (unknown)	0188
	Loras College, Wahlert Memorial Library (1967)	0194A
Fayette	Upper Iowa University, Henderson-Wilder Library (1974)	0190A
Grinnell	Grinnell College Library (1874)	0192
Iowa City	University of Iowa, Law Library (1968)	0188A
	University of Iowa Libraries (1884)—REGIONAL	0189A
Lamoni	Graceland College, Frederick Madison Smith Library	0192A
Mason City	North Iowa Area Community College Library (1976)	0191A
Mount Vernon	Cornell College, Russell D. Cole Library (1896)	0190
Orange City	Northwestern College, Ramaker Library (1970)	0196A
Sioux City	Sioux City Public Library (1894)	0196

KANSAS

Atchison	Benedictine College Library (1965)	0201
Baldwin City	Baker University, Collins Library (1908)	0202
Colby	Colby Community College Library (1968)	0199A
Emporia	Emporia Kansas State University, William Allen White Library (1909)	0204
Fort Scott	Fort Scott Community College, Learning Resource Center Library (1979)	0204B
Hays	Fort Hays State University, Forsyth Library (1936)	0206A
Hutchinson	Hutchinson Public Library (1963)	0200A

LIST OF DEPOSITORY LIBRARIES

		Depository No.
Lawrence	University of Kansas, School of Law Library (1971)	0202A
	University of Kansas Libraries (1869)—REGIONAL	0199
Manhattan	Kansas State University Library (1907)	0198
Pittsburg	Pittsburg State University Library (1952)	0203
Salina	Kansas Wesleyan University, Memorial Library (1930)	0206
Shawnee Mission	Johnson County Library (1979)	0203A
Topeka	Kansas Judicial Center (1975)	0197A
	Kansas State Historical Society Library (1877)	0200
	Kansas State Library (unknown)	0197
	Washburn University at Topeka, Law Library (1971)	0201A
Wichita	Wichita State University Library (1901)	0204A

KENTUCKY

Ashland	Boyd County Public Library (1946)	0219
Barbourville	Union College, Abigail E. Weeks Memorial Library (1958)	0220
Bowling Green	Western Kentucky University, Helm-Cravens Library (1934)	0213
Danville	Centre College, Grace Doherty Library (1884)	0217A
Fort Mitchell	Thomas More College Library (1970)	0209
Frankfort	Kentucky Department of Libraries and Archives (1967)	0211A
	Kentucky State Law Library (unknown)	0207
	Kentucky State University, Blazer Library (1972)	0207A
Highland Heights	Northern Kentucky University, W. Frank Steeley Library (1973)	0217B
Hopkinsville	Hopkinsville Community College Library (1976)	0212A
Lexington	University of Kentucky, Law Library (1968)	0210A
	University of Kentucky Library (1907)—REGIONAL	0208
Louisville	Louisville Free Public Library (1904)	0214
	University of Louisville, Law Library (1975)	0214A
	University of Louisville, Ekstrom Library (1925)	0211
Morehead	Morehead State University, Camden-Carroll Library (1955)	0210
Murray	Murray State University, Waterfield Library (1924)	0212
Owensboro	Kentucky Wesleyan College Library Learning Center (1966)	0213A
Richmond	Eastern Kentucky University, John Grant Carbbe Library (1966)	0217

LOUISIANA

Baton Rouge	Louisiana State Library (1976)	0231B
	Louisiana State University, Paul M. Hebert Law Center Library (1929)	0231
	Louisiana State University, Middleton Library (1907)—REGIONAL	0222
	Southern University Law School Library (1979)	0225A
	Southern University Library (1952)	0223
Eunice	Louisiana State University at Eunice, LeDoux Library (1969)	0232A
Hammond	Southeastern Louisiana University, Sims Memorial Library (1966)	0231A
Lafayette	University of Southwestern Louisiana Library (1938)	0228
Lake Charles	McNeese State University, Frazer Memorial Library (1941)	0232
Monroe	Northeast Louisiana University, Sandel Library (1963)	0230A
Natchitoches	Northwestern State University, Watson Memorial Library (1887)	0233
New Orleans	Louisiana Law Library (unknown)	0221
	Loyola University, Law Library (1978)	0221A
	Loyola University Library (1942)	0227
	New Orleans Public Library (1883)	0224
	Our Lady of Holy Cross College Library (1982)	0224B
	Southern University in New Orleans Library (1962)	0226
	Tulane University, Howard-Tilton Memorial Library (1942)	0225
	Tulane University, Law Library (1976)	0227A
	U.S. Court of Appeals, Fifth Circuit Library (1973)	1031
	University of New Orleans, Earl K. Long Library (1963)	0224A
Pineville	Louisiana College, Richard W. Norton Memorial Library (1969)	0233A
Ruston	Louisiana Technical University, Prescott Memorial Library (1896)—REGIONAL	0230
Shreveport	Louisiana State University at Shreveport Library (1967)	0229A
	Shreve Memorial Library (1923)	0229
Thibodaux	Nicholls State University, Ellender Memorial Library (1962)	0228A

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MAINE

		Depository No.
Augusta	Maine Law and Legislative Reference Library (1973)	0234A
	Maine State Library (unknown)	0234
Bangor	Bangor Public Library (1884)	0240
Brunswick	Bowdoin College, Hawthorne Longfellow Library (1884)	0237
Castine	Maine Marine Academy, Nutting Memorial Library (1969)	0236A
Lewiston	Bates College, George and Helen Ladd Library (1883)	0239
Orono	University of Maine, Raymond H. Fogler Library (1907)—REGIONAL	0235
Portland	Portland Public Library (1884)	0238
	University of Maine Law Library (1964)	0237A
Presque Isle	University of Maine at Presque Isle Library/Learning Resources Center (1979)	0238A
Springvale	Nasson College Library (1961)	0236
Waterville	Colby College, Miller Library (1884)	0239A

MARYLAND

Annapolis	Maryland State Law Library (unknown)	0241
	U.S. Naval Academy, Nimitz Library (1895)	0244
Baltimore	Enoch Pratt Free Library (1887)	0246
	Johns Hopkins University, Milton S. Eisenhower Library (1882)	0245
	Morgan State College, Soper Library (1940)	0249
	Towson State University, Cook Library	0249B
	University of Baltimore, University Library (1973)	0249A
	University of Baltimore Law Library (1980)	0241B
	University of Maryland School of Law Library (1969)	0241A
Bel Air	Harford Community College Library (1967)	0248B
Beltsville	Agriculture Department, National Agricultural Library (1895)	0092
Bethesda	Health and Human Services Department, National Library of Medicine (1978)	1046
Catonsville	University of Maryland, Baltimore County, University Library (1971)	0246A
Chestertown	Washington College, Clifton M. Miller Library (1891)	0247
College Park	University of Maryland, McKeldin Library (1925)—REGIONAL	0242
Cumberland	Allegany Community College Library (1974)	0245A
Frostburg	Frostburg State College Library (1967)	0248C
Patuxent River	U.S. Naval Air Station Library (1968)	1021
Rockville	Montgomery County, Department of Public Libraries (1951)	0252
Salisbury	Salisbury State College, Blackwell Library (1965)	0247A
Towson	Goucher College, Julia Rogers Library (1966)	0248A
	Towson State University, Cook Library (1979)	0249B
Westminister	Western Maryland College, Hoover Library (1886)	0248

MASSACHUSETTS

Amherst	Amherst College Library (1884)	0260
	University of Massachusetts, Goodell Library (1907)	0254
Belmont	Belmont Memorial Library (1968)	0264
Boston	Boston Athenaeum Library (unknown)	0269
	Boston Public Library (1850)—REGIONAL	0268A
	Boston University School of Law Pappas Law Library (1979)	0255A
	Northeastern University, Dodge Library (1962)	0268B
	State Library of Massachusetts (unknown)	0253
	Suffolk University Law Library (1979)	0256B
	Supreme Judicial Court, Social Law Library (1979)	0259A
	U.S. Court of Appeals, First Circuit Library (1978)	0270A
Brookline	Public Library of Brookline (1925)	0268
Cambridge	Harvard College Library (1860)	0257
	Harvard Law School Library (1981)	0261A
	Massachusetts Institute of Technology Libraries (1946)	0255
Chestnut Hill	Boston College, Bapst Library (1963)	0257A
Chicopee	College of Our Lady of the Elms, Alumnae Library (1969)	0261
Lowell	University of Lowell, Alumni-Lyndon Library (1952)	0263
Lynn	Lynn Public Library (1953)	0265
Marlborough	Marlborough Public Library (1971)	0263A

LIST OF DEPOSITORY LIBRARIES

		Depository No.
Medford	Tufts University Library (1899)	0258
Milton	Curry College, Levin Library (1972)	0270
New Bedford	New Bedford Free Public Library (1858)	0267
Newton Centre	Boston College, Law School Library (1979)	0254A
North Dartmouth	Southeastern Massachusetts University Library (1965)	0267A
North Easton	Stonehill College, Cushing-Martin Library (1962)	0272A
Springfield	Springfield City Library (1966)	0258A
	Western New England College, Law Library (1978)	0256A
Waltham	Brandeis University Library (1965)	0262A
Wellesley	Wellesley College Library (1943)	0272
Wenham	Gordon College, Winn Library (1963)	0265A
Williamstown	Williams College Library (unknown)	0259
Worcester	American Antiquarian Society Library (1814)	0256
	University of Massachusetts Medical Center, Lamar Soutter Library (1972)	0262B
	Worcester Public Library (1859)	0262

MICHIGAN

Albion	Albion College, Stockwell Memorial Library (1966)	0279B
Allendale	Grand Valley State College, Zumberge Library (1963)	0281A
Alma	Alma College Library (1963)	0284A
Ann Arbor	University of Michigan, Harlan Hatcher Library (1884)	0278
	University of Michigan, Law Library (1978)	0276A
Benton Harbor	Benton Harbor Public Library (1907)	0280
Bloomfield Hills	Cranbrook Institute of Science Library (1940)	0293
Dearborn	Henry Ford Centennial Library (1969)	0292C
	Henry Ford Community College Library (1957)	0292
Detroit	Detroit College of Law Library (1979)	0278B
	Detroit Public Library (1868)—REGIONAL	0275
	Marygrove College Library (1965)	0277
	Mercy College of Detroit Library (1965)	0277A
	University of Detroit Library (1884)	0291
	University of Detroit, School of Law Library (1978)	0276B
	Wayne State University, G. Flint Purdy Library (1937)	289
	Wayne State University, Arthur Neef Law Library (1971)	0289A
Dowagiac	Southwestern Michigan College, Matthews Library (1971)	0280A
East Lansing	Michigan State University Library (1907)	0274
Farmington Hills	Oakland Community College, Martin L. King Learning Resources Center (1968)	0283A
Flint	Flint Public Library (1967)	0282A
	University of Michigan-Flint Library (1959)	0282
Grand Rapids	Calvin College and Seminary Library (1967)	0281B
	Grand Rapids Public Library (1876)	0281
Houghton	Michigan Technological University Library (1876)	0288
Jackson	Jackson District Library (1965)	0273A
Kalamazoo	Kalamazoo Public Library (1907)	0276
	Western Michigan University, Dwight B. Waldo Library (1963)	0279A
Lansing	Michigan State Library (unknown)—REGIONAL	0273
	Thomas M. Cooley Law School Library (1978)	0277B
Livonia	Schoolcraft College Library (1962)	0292B
Marquette	Northern Michigan University, Olson Library (1963)	0288A
Monroe	Monroe County Library System (1974)	0291B
Mount Clemens	Macomb County Library (1968)	0274A
Mount Pleasant	Central Michigan University Library (1958)	0286
Muskegon	Hackley Public Library (1894)	0285
Olivet	Olivet College Library (1974)	0279C
Petoskey	Northern Central Michigan College Library (1962)	0287
Port Huron	Saint Clair County Library (1876)	0283
Rochester	Oakland University, Kresge Library (1964)	0293A
Saginaw	Hoyt Public Library (1890)	0284
Sault Ste. Marie	Lake Superior State College, Kenneth Shouldice Library (1982)	0287B
Traverse City	Northwestern Michigan College, Mark Osterlin Library (1964)	0285A
University Center	Delta College Learning Resources Center (1963)	0286A

		Depository No.
Warren	Warren Public Library Arthur J. Miller Branch (1973)	0291A
Wayne	Wayne County Public Library (1957)	0292A
Ypsilanti	Eastern Michigan University Library (1965)	0278A

MICRONESIA

East Caroline Islands	Community College of Micronesia Library (1982)	0293B

MINNESOTA

Bemidji	Bemidji State University, A. C. Clark Library (1963)	0306A
Collegeville	Saint John's University, Alcuin Library (1954)	0303
Duluth	Duluth Public Library (1909)	0305
Mankato	Mankato State University, Memorial Library (1962)	0299A
Minneapolis	Anoka County Library (1971)	0295A
	Hennepin County Libraries (1971)	0300A
	Minneapolis Public Library (1893)	0302
	University of Minnesota, Law School Library (1978)	0294A
	University of Minnesota, Wilson Library (1970)—REGIONAL	0295
Moorhead	Moorhead State University Library (1956)	0306
Morris	University of Minnesota, Morris, Rodney Briggs Library (1963)	0304A
Northfield	Carleton College Library (1930)	0296
	Saint Olaf College, Rolvaag Memorial Library (1930)	0298
Saint Cloud	Saint Cloud State University, Learning Resources Center (1962)	0303A
Saint Paul	Hamline University, School of Law Library (1978)	0297A
	Minnesota Historical Society Library (1867)	0301
	Minnesota State Law Library (unknown)	0294
	Saint Paul Public Library (1914)	0297
	University of Minnesota, Saint Paul Campus Library (1974)	0301A
	William Mitchell College of Law Library (1979)	0296A
Saint Peter	Gustavus Adolphus College Library (1941)	0299
Stillwater	Stillwater Public Library (1893)	0300
Willmar	Crow River Regional Library (1958)	0304
Winona	Winona State University, Maxwell Library (1969)	0298A

MISSISSIPPI

Cleveland	Delta State University, W. B. Roberts Library (1975)	0313A
Columbus	Mississippi University for Women, J. C. Fant Memorial Library (1929)	0313
Hattiesburg	University of Southern Mississippi, Joseph A. Cook Memorial Library (1935)	0315
Jackson	Jackson State University, Henry Thomas Sampson Library (1968)	0314
	Millsaps College, Millsaps-Wilson Library (1963)	0310
	Mississippi College School of Law Library (1981)	0314A
	Mississippi Library Commission (1947)	0311
	Mississippi State Library (unknown)	0307
Lorman	Alcorn State University Library (1970)	0308A
State College	Mississippi State University, Mitchell Memorial Library (1907)	0308
University	University of Mississippi, Law Library (1967)	0309
	University of Mississippi Library (1883)—REGIONAL	0312

MISSOURI

Cape Girardeau	Southeast Missouri State University (1916)	0334
Columbia	University of Missouri at Columbia Library (1862)	0321
	University of Missouri-Columbia, Law Library (1978)	0332A
Fayette	Central Methodist College, George M. Smiley Library (1962)	0334A
Fulton	Westminister College, Reeves Library (1875)	0333
Jefferson City	Lincoln University, Inman E. Page Library (1944)	0322
	Missouri State Library (1963)	0334B
	Missouri Supreme Court Library (unknown)	0320

LIST OF DEPOSITORY LIBRARIES

		Depository No.
Joplin	Missouri Southern State College Library (1966)	0330C
Kansas City	Kansas City Public Library (1881)	0328
	Rockhurst College, Greenlease Library (1917)	0324
	University of Missouri at Kansas City, General Library (1938)	0329
	University of Missouri at Kansas City, Leon E. Bloch Law Library (1978)	0321A
Kirksville	Northeast Missouri State University, Pickler Memorial Library (1966)	0323A
Liberty	William Jewell College, Charles F. Curry Library (1900)	0327
Maryville	Northwest Missouri State University, Wells Library (1982)	0325A
Rolla	University of Missouri-Rolla, Curtis Laws Wilson Library (1907)	0332
Saint Charles	Lindewood Colleges, Margaret Leggat Butler Library (1973)	0333A
Saint Joseph	Saint Joseph Public Library (1891)	0327A
Saint Louis	Maryville College Library (1976)	0336B
	Saint Louis County Library (1970)	0336A
	Saint Louis Public Library (1866)	0335
	Saint Louis University Law Library (1967)	0335A
	Saint Louis University, Pius XII Memorial Library (1866)	0323
	U.S. Court of Appeals, Eighth Circuit Library (1972)	1030
	University of Missouri at Saint Louis, Thomas Jefferson Library (1966)	0326
	Washington University, John M. Olin Library (1906)	0336
	Washington University Law Library (1978)	0320A
Springfield	Drury College, Walker Library (1874)	0330A
	Southwest Missouri State College Library (1963)	0330B
Warrensburg	Central Missouri State University, Ward Edwards Library (1914)	0330

MONTANA

Billings	Eastern Montana College Library (1958)	0343
Bozeman	Montana State University, Renne Library (1907)	0339
Butte	Montana College of Mineral Science & Technology Library (1901)	0340
Havre	Northern Montana College Library (1980)	0339A
Helena	Carroll College Library (1974)	0342A
	Montana Historical Society Library (unknown)	0338
	Montana State Law Library (1977)	0338A
	Montana State Library (1966)	0342
Missoula	University of Montana, Maureen & Mike Mansfield Library (1909)—REGIONAL	0341

NEBRASKA

Blair	Dana College, Dana-LIFE Library (1924)	0349
Crete	Doane College, Perkins Library (1944)	0348
Fremont	Midland Lutheran College, Luther Library (1924)	0350
Kearney	Kearney State College, Calvin T. Ryan Library (1962)	0351A
Lincoln	Nebraska Library Commission (1972)—REGIONAL	0346A
	Nebraska State Library (unknown)	0344
	University of Nebraska-Lincoln, D. L. Love Memorial Library (1907)—REGIONAL	0345
	University of Nebraska-Lincoln, College of Law Library (1981)	034[illegible]
Omaha	Creighton University, Alumni Memorial Library (1964)	0349A
	Creighton University, Law Library (1979)	0348A
	Omaha Public Library (1880)	0346
	University of Nebraska at Omaha, University Library (1939)	0347
Scottsbluff	Scottsbluff Public Library (1925)	0351
Wayne	Wayne State College, U.S. Conn Library (1970)	0347A

NEVADA

Carson City	Nevada State Library (unknown)	0352
	Nevada Supreme Court Library (1973)	0352A
Las Vegas	Clark County Library District (1974)	0353B
	University of Nevada at Las Vegas, James Dickinson Library (1959)	0355

		Depository No.
Reno	National Judicial College Law Library (1979)	0355A
	Nevada Historical Society Library (1974)	0353A
	University of Nevada Library (1907)—REGIONAL	0353
	Washoe County Library (1980)	0354

NEW HAMPSHIRE

Concord	Franklin Pierce Law Center Library (1973)	0359B
	New Hampshire State Library (unknown)	0357
Durham	University of New Hampshire Library (1907)	0358
Hanover	Dartmouth College Library (1884)	0362
Henniker	New England College, Danforth Library (1966)	0362A
Manchester	Manchester City Library (1884)	0360
	New Hampshire College, H. A. B. Shapiro Memorial Library (1976)	0358A
	St. Anselm's College, Geisel Library (1963)	0359
Nashua	Nashua Public Library (1971)	0360A

NEW JERSEY

Bayonne	Bayonne Free Public Library (1909)	0379
Bloomfield	Bloomfield Public Library (1965)	0376A
Bridgeton	Cumberland County Library (1966)	0368A
Camden	Rutgers University, Camden Library (1966)	0367
	Rutgers University, School of Law Library (1979)	0371A
Convent Station	College of St. Elizabeth, Mahoney Library (1938)	0365
East Brunswick	East Brunswick Public Library (1977)	0366B
East Orange	East Orange Public Library (1966)	0377A
Elizabeth	Free Public Library of Elizabeth (1895)	0372
Glassboro	Glassboro State College, Savitz Learning Resource Center (1963)	0367A
Hackensack	Johnson Free Public Library (1966)	0374
Irvington	Free Public Library of Irvington (1966)	0380
Jersey City	Jersey City Public Library (1879)	0379A
	Jersey City State College, F. A. Irwin Library (1963)	0365A
Lawrenceville	Rider College, Franklin F. Moore Library (1975)	0370B
Madison	Drew University, Rose Memorial Library (1939)	0371
Mahwah	Ramapo College Library (1971)	0374A
Mount Holly	Burlington County Library (1966)	0370A
New Brunswick	New Brunswick Free Public Library (1908)	0369
	Rutgers University, Alexander Library (1907)	0364
Newark	Newark Public Library (1906)—REGIONAL	0376
	Rutgers, The State University Law School, Newark, Ackerson Law Library (1979)	0378A
	Rutgers, The State University, John Cotton Dana Library (1966)	0366A
	Seton Hall University, School of Law Library (1979)	0378B
Passaic	Passaic Public Library (1964)	0364A
Pemberton	Burlington County College Library (1979)	0377B
Phillipsburg	Phillipsburg Free Public Library (1976)	0365B
Plainfield	Plainfield Public Library (1971)	0372A
Pomona	Stockton State College Library (1972)	0367B
Princeton	Princeton University Library (1884)	0370
Randolph Township	County College of Morris, Masten Learning Resource Center (1975)	0363B
Rutherford	Fairleigh Dickinson University, Messler Library (1953)	0375
Shrewsbury	Monmouth County Library, Eastern Branch (1968)	0363A
South Orange	Seton Hall University, McLaughlin Library (1947)	0377
Teaneck	Fairleigh Dickinson University, Teaneck/Hackensack Campus Library (1963)	0375A
Toms River	Ocean County College, Learning Resources Center (1966)	0373A
Trenton	New Jersey State Library (unknown)	0363
	Trenton Free Public Library (1902)	0366
Union	Kean College of New Jersey, Nancy Thompson Library (1973)	0376B
Upper Montclair	Montclair State College, Harry A. Sprague Library (1967)	0380A
Wayne	Wayne Public Library (1972)	0364B
West Long Beach	Monmouth College, Guggenheim Memorial Library (1963)	0373
Woodbridge	Free Public Library of Woodbridge (1965)	0369A

LIST OF DEPOSITORY LIBRARIES

NEW MEXICO

		Depository No.
Albuquerque	University of New Mexico, Medical Center Library (1973)	0381A
	University of New Mexico, School of Law Library (1973)	0386A
	University of New Mexico, General Library (1896)—REGIONAL	0383
Hobbs	New Mexico Junior College, Pannell Library (1969)	0385
Las Cruces	New Mexico State University Library (1907)	0382
Las Vegas	New Mexico Highlands University, Donnelly Library (1913)	0384
Portales	Eastern New Mexico University, Golden Library (1962)	0383A
Sante Fe	New Mexico State Library (1960)—REGIONAL	0386
	New Mexico Supreme Court Law Library (unknown)	0381
Silver City	Western New Mexico University, Miller Library (1972)	0385A

NEW YORK

Albany	Albany Law School Library (1979)	0421B
	New York State Library (unknown)—REGIONAL	0387
	State University of New York at Albany, University Library (1964)	0421A
Auburn	Seymour Library (1972)	0431
Bayside	Queensborough Community College Library (1972)	0418
Binghamton	State University of New York at Binghamton, Glen G. Bartle Library (1962)	0425A
Brockport	State University of New York at Brockport, Drake Memorial Library (1967)	0430A
Bronx	Fordham University Library (1937)	0414
	Herbert H. Lehman College Library (1967)	0390C
	New York Public Library, Mott Haven Branch (1973)	0411
	State University of New York, Maritime College, Stephen B. Luce Library (1947)	0416
Brooklyn	Brooklyn College Library (1936)	0397
	Brooklyn Law School Library (1974)	0396B
	Brooklyn Public Library (1908)	0398
	Polytechnic Institute of New York, Spicer Library (1963)	0396A
	Pratt Institute Library (1891)	0396
	State University of New York, Downstate Medical Center Library (1958)	0404
Buffalo	Buffalo and Erie County Public Library (1895)	0432
	State University of New York at Buffalo, C. B. Sears Law Library (1978)	0400B
	State University of New York at Buffalo, Lockwood Memorial Library (1963)	0433
Canton	Saint Lawrence University, Owen D. Young Library (1920)	0391
Cheektowaga	Cheektowaga Public Library	0388A
Corning	Corning Community College, Arthur A. Houghton Jr. Library (1963)	0434A
Cortland	State University of New York College at Cortland, Memorial Library (1964)	0399
Delhi	State University Agricultural and Technical College Library (1970)	0417A
Douglaston	Cathedral College Library (1971)	0395A
East Islip	East Islip Public Library (1973)	0394B
Elmira	Elmira College, Gannett Tripp Learning Center (1956)	0425
Farmingdale	State University of New York at Farmingdale Library (1917)	0392
Flushing	Queens College, Paul Klapper Library (1939)	0435
Garden City	Adelphi University, Swirbul Library (1966)	0390A
Geneseo	State University of New York at Geneseo Milne Library (1967)	0430
Greenvale	Long Island University, B. Davis Schwartz Memorial Library (1964)	0395
Hamilton	Colgate University, Case Library (1902)	0423
Hempstead	Hofstra University Library (1964)	0427
	Hofstra University, School of Law Library (1979)	0393B
Ithaca	Cornell Law Library, Myron Taylor Hall (1978)	0435A
	Cornell University Library (1907)	0388
	New York State College of Agriculture and Human Economics, Albert R. Mann Library (1943)	0428
Jamaica	Queens Borough Public Library (1926)	0393
	Saint John's University Library (1956)	0401
	Saint John's University, School of Law Library (1978)	0393A
Kings Point	U.S. Merchant Marine Academy Library (1962)	0400
Long Island City	Fiorello H. LaGuardia Community College Library (1981)	0409A
Mount Vernon	Mount Vernon Public Library (1962)	0419
New Paltz	State University College at New Paltz, Sojourner Truth Library (1965)	0436A

		Depository No.
New York City	Cardoza Law School Library (1979)	0411A
	City University of New York, City College Library (1884)	0412
	College of Insurance Library (1965)	0402A
	Columbia University Libraries (1882)	0410
	Columbia University, School of Law Library (1981)	0405A
	Cooper Union for the Advancement of Science and Arts Library (1930)	0405
	Medical Library Center of New York (1976)	0412A
	New York Law Institute Library (1909)	0402
	New York Law School Library (1979)	0426A
	New York Public Library, Astor Branch (1907)	0408
	New York Public Library, Lenox Branch (1884)	0408A
	New York University Law Library (1973)	0390
	New York University, Elmer Holmes Bobst Library (1967)	0390B
	U.S. Court of Appeals, Second Circuit Library (1976)	1041
	Yeshiva University, Pollack Library (1979)	0410A
Newburgh	Newburgh Free Library (1909)	0417
Niagara Falls	Niagara Falls Public Library (1976)	0430B
Oakdale	Dowling College Library (1965)	0394A
Oneonta	State University College at Oneonta, James M. Milne Library (1966)	0399A
Oswego	State University College at Oswego, Penfield Library (1966)	0391A
Plattsburgh	State University College at Plattsburgh, Benjamin F. Feinberg Library (1967)	0420B
Potsdam	Clarkson College of Technology, Harriet Call Burnap Memorial Library (1938)	0422
	State University College at Potsdam, Frederick W. Crumb Memorial Library (1964)	0422A
Poughkeepsie	Vassar College Library (1943)	0436
Purchase	State University of New York, College at Purchase Library (1969)	0419A
Rochester	Rochester Public Library (1963)	0429A
	University of Rochester, Rush Rhees Library (1880)	0429
Saint Bonaventure	Saint Bonaventure University, Friedsam Memorial Library (1938)	0434
Saratoga Springs	Skidmore College Library (1964)	0420
Schnectady	Union College, Schaffer Library (1901)	0421
Southampton	Southampton College Library (1973)	0395B
Staten Island	Wagner College, Horrmann Library (1953)	0409
Stony Brook	State University of New York at Stony Brook Library (1963)	0394
Syracuse	Onondaga County Public Library (1978)	0431A
	Syracuse University Library (1878)	0426
	Syracuse University, William C. Ruger Law Library (1978)	0389A
Troy	Troy Public Library (1869)	0420A
Uniondale	Nassau Library System (1965)	0427A
Utica	SUNY College of Technology Library (1977)	0424A
	Utica Public Library (1885)	0424
West Point	U.S. Military Academy Cadet Library (unknown)	0389
White Plains	Pace University Law School Library (1978)	0400A
Yonkers	Sarah Lawrence College Library (1969)	0415A
	Yonkers Public Library (1910)	0415
Yorktown Heights	Mercy College Library, Yorktown Branch Campus (1976)	0436B

NORTH CAROLINA

Asheville	University of North Carolina at Asheville, D. Hiden Ramsey Library (1965)	0453A
Boiling Springs	Gardner Webb College, Dover Memorial Library (1974)	0450B
Boone	Appalachian State University Library (1963)	0450A
Buies Creek	Campbell University, Carrie Rich Memorial Library (1965)	0449
Chapel Hill	University of North Carolina, Wilson Library (1884)—REGIONAL	0447
	University of North Carolina, Law Library (1978)	0437B
Charlotte	Public Library of Charlotte and Mecklenburg County (1964)	0451A
	Queens College, Everett Library (1927)	0451
	University of North Carolina at Charlotte, Atkins Library (1964)	0451B
Cullowhee	Western Carolina University, Hunter Library (1953)	0453
Davidson	Davidson College Library (1893)	0441
Durham	Duke University, School of Law Library (1978)	0440A
	Duke University, William R. Perkins Library (1890)	0440

LIST OF DEPOSITORY LIBRARIES

		Depository No.
	North Carolina Central University, James E. Shepard Memorial Library (1973)	0445B
	North Carolina Central University, Law Library (1979)	0438A
Elon College	Elon College, Iris Holt McEwen Library (1971)	0439A
Fayetteville	Fayetteville State University, Chestnutt Library (1971)	0441A
Greensboro	North Carolina Agricultural and Technical State University, F. D. Bluford Library (1937)	0439
	University of North Carolina at Greensboro, Walter Clinton Jackson Library (1963)	0447A
Greenville	East Carolina University, J. Y. Joyner Library (1951)	0442
Laurinburg	St. Andrew's Presbyterian College, DeTamble Library (1969)	0452
Lexington	Davidson County Public Library (1971)	0446A
Mount Olive	Mount Olive College, Moye Library (1971)	0449A
Murfreesboro	Chowan College, Whitaker Library (1963)	0442A
Pembroke	Pembroke State University, Mary H. Livermore Library (1956)	0448
Raleigh	Department of Cultural Resources State Library (unknown)	0437
	North Carolina State University, D. H. Hill Library (1923)	0438
	North Carolina Supreme Court Library (1972)	0437A
	Wake County Public Library (1969)	0445A
Rocky Mount	North Carolina Wesleyan College Library (1969)	0443A
Salisbury	Catawba College Library (1925)	0450
Wilmington	University of North Carolina at Wilmington, William M. Randall Library (1965)	0448A
Wilson	Atlantic Christian College, Clarence L. Hardy Library (1930)	0443
Winston-Salem	Forsyth County Public Library (1954)	0446
	Wake Forest University, Z. Smith Reynolds Library (1902)	0445

NORTH DAKOTA

Bismarck	North Dakota State Historical Society Library (1907)	0457
	North Dakota State Library (1971)	0457A
	North Dakota Supreme Court Law Library (unknown)	0454
	Veteran's Memorial Public Library (1967)	9456A
Dickinson	Dickinson State College, Stoxen Library (1968)	0459A
Fargo	Fargo Public Library (1964)	0458A
	North Dakota State University Library (1907)	0455
Grand Forks	University of North Dakota, Chester Fritz Library (1890)	0456
Minot	Minot State College, Memorial Library (1925)	0459
Valley City	Valley City State College Library (1913)	0458

OHIO

Ada	Ohio Northern University, J. P. Taggart Law Library (1965)	0485B
Akron	Akron-Summit County Public Library (1952)	0477B
	University of Akron, Bierce Library (1963)	0477C
	University of Akron, School of Law Library (1978)	0463B
Alliance	Mt. Union College Library (1888)	0479
Ashland	Ashland College Library (1938)	0486
Athens	Ohio University Library (1886)	0473
Batavia	University of Cincinnati at Batavia, Clermont General and Technical College Library (1973)	0464A
Bluffton	Bluffton College, Musselman Library (1951)	0467
Bowling Green	Bowling Green State University Library (1933)	0476
Canton	Malone College, Everett L. Cattell Library (1970)	0479B
Chardon	Geauga County Public Library (1971)	0465A
Cincinnati	Public Library of Cincinnati and Hamilton County (1884)	0464
	University of Cincinnati College of Law, Marx Law Library (1978)	0461A
	University of Cincinnati, Central Library (1929)	0465
Cleveland	Case Western Reserve University, Freiberger Library (1913)	0485A
	Case Western Reserve University, School of Law Library (1979)	0475A
	Cleveland Heights University, Public Library (1970)	0471A
	Cleveland Public Library (1886)	0463
	Cleveland State University, Cleveland-Marshall College of Law Library (1978)	0463A
	Cleveland State University Library (1966)	0471
	John Carroll University, Grasselli Library (1963)	0460A
	Municipal Reference Library (1970)	0471B

		Depository No.
Columbus	Capital University Law School Library (1980)	0468A
	Capitol University Libraries (1968)	0474A
	Ohio State Library (unknown)—REGIONAL	0460
	Ohio State University Libraries (1907)	0461
	Ohio Supreme Court Law Library (1973)	0460B
	Public Library of Columbus and Franklin County (1885)	0475
Dayton	Dayton and Montgomery County Public Library (1909)	0466
	University of Dayton, Roesch Library (1969)	0467A
	Wright State University Library (1965)	0462A
Delaware	Ohio Wesleyan University, L. A. Beeghly Library (1845)	0480A
Elyria	Elyria Public Library (1966)	0476A
Findlay	Findlay College, Shafer Library (1969)	0483A
Gambier	Kenyon College Library (1873)	0462
Granville	Denison University Libraries, W. H. Doane Library (1884)	0480
Hiram	Hiram College, Teachout Price Memorial Library (1874)	0477A
Kent	Kent State University Library (1962)	0483
Marietta	Marietta College, Dawes Memorial Library (1884)	0478
Marion	Marion Public Library (1979)	0470A
Middletown	Miami University at Middletown, Gardner-Harvey Library (1970)	0466B
New Concord	Muskingum College Library (1966)	0478A
Oberlin	Oberlin College Library (1858)	0477
Oxford	Miami University at Oxford, King Library (1909)	0466A
Portsmouth	Portsmouth Public Library (unknown)	0469
Rio Grande	Rio Grande College and Community College, Jeanette Albiez Davis Library (1966)	0473A
Springfield	Warder Public Library (1884)	0470
Steubenville	College of Steubenville, Starvaggi Memorial Library (1971)	0481A
	Steubenville and Jefferson County Public Library (1950)	0481
Tiffin	Heidelberg College, Beeghly Library (1964)	0485
Toledo	Toledo-Lucas County Public Library (1884)	0472
	University of Toledo, College of Law Library (1981)	0486A
	University of Toledo Library (1963)	0472A
Westerville	Otterbein College, Courtright Memorial Library (1967)	0474
Wooster	College of Wooster, Andrews Library (1966)	0479A
Youngstown	Youngstown and Mahoning County Public Library (1923)	0482
	Youngstown State University, William F. Maag Library (1971)	0482A

OKLAHOMA

Ada	East Central Oklahoma State University, Linscheid Library (1914)	0490
Alva	Northwestern Oklahoma State University Library (1907)	0499
Bartlesville	Department of Energy, Bartlesville Energy Research Center Library (1962)	1003
Bethany	Bethany Nazarene College, R. T. Williams Library (1971)	0489A
Durant	Southeastern Oklahoma State University Library (1929)	0494
Edmond	Central State University Library (1934)	0496A
Enid	Public Library of Enid and Garfield County (1908)	0499A
Langston	Langston Univeristy, G. Lamar Harrison Library (1941)	0489
Muskogee	Muskogee Public Library (1971)	0493
Norman	University of Oklahoma Library (18[illegible])	0496
	University of Oklahoma, Law Library (1978)	0488A
Oklahoma City	Metropolitan Library System (1974)	0487A
	Oklahoma City University Library (1963)	0497B
	Oklahoma Department of Libraries (1893)—REGIONAL	0487
Shawnee	Oklahoma Baptist University Library (1933)	0495
Stillwater	Oklahoma State University Library (1907)—REGIONAL	0488
Tahlequah	Northeastern Oklahoma State University, John Vaughan Library (1923)	0491
Tulsa	Tulsa City-County Library (1963)	0491A
	University of Tulsa, College of Law Library (1979)	0490A
	University of Tulsa, McFarlin Library (1929)	0492
Weatherford	Southwestern Oklahoma State University, Al Harris Library (1958)	0497

LIST OF DEPOSITORY LIBRARIES

OREGON

		Depository No.
Ashland	Southern Oregon College Library (1953)	0507
Corvallis	Oregon State University Library (1907)	0501
Eugene	University of Oregon, Law Library (1979)	0507A
	University of Oregon Library (1883)	0502
Forest Grove	Pacific University, Harvey W. Scott Library (1897)	0504
La Grande	Eastern Oregon College, Walter M. Pierce Library (1954)	0505
McMinnville	Linfield College, Northup Library (1965)	0502A
Monmouth	Western Oregon State College Library (1967)	0503A
Portland	Department of Energy, Bonneville Power Administration Library (1962)	1007
	Lewis and Clark College, Aubrey R. Watzek Library (1967)	0504A
	Northwestern School of Law, Paul L. Boley Law Library (1979)	0501B
	Portland Library Association (1884)	0506
	Portland State University Library (1963)—REGIONAL	0506A
	Reed College Library (1912)	0503
Salem	Oregon State Library (unknown)	0500
	Oregon Supreme Court Library (1974)	0500A
	Willamette University, College of Law Library (1979)	0501A
	Willamette University, Main Library (1969)	0505A

PENNSYLVANIA

Allentown	Muhlenberg College, Haas Library (1939)	0520
Altoona	Altoona Public Library (1969)	0523
Bethel Park	Bethel Park Public Library (1980)	0512
Bethlehem	Lehigh University Library (1876)	0532
Blue Bell	Montgomery County Community College, Learning Resources Center (1975)	0519C
Bradford	University of Pittsburgh at Bradford, Bradford Campus Library (1979)	0531B
Carlisle	Dickinson College, Boyd Lee Spahr Library (1947)	0530
	Dickinson School of Law, Sheely-Lee Law Library (1978)	0528A
Cheyney	Cheyney State College, Leslie Pinckney Hill Library (1967)	0521B
Collegeville	Ursinus College, Myrin Library (1963)	0519A
Coraopolis	Robert Morris College Library (1978)	0509B
Doylestown	Bucks County Free Library, Center County Branch (1970)	0518A
East Stroudsburg	East Stroudsburg State College, Kemp Library (1966)	0532A
Erie	Erie County Library System (1897)	0540A
Greenville	Thiel College, Langenheim Memorial Library (1963)	0510A
Harrisburg	Pennsylvania State Library (unknown)—REGIONAL	0508
Haverford	Haverford College, Magill Library (1897)	0519
Hazleton	Hazleton Area Public Library (1964)	0522B
Indiana	Indiana University of Pennsylvania, Rhodes R. Stabley Library (1962)	0533
Johnstown	Cambria County Library System, Glosser Memorial Library (1965)	0533A
Lancaster	Franklin and Marshall College Fackenthal Library (1895)	0521
Lewisburg	Bucknell University, Ellen Clark Bertrand Library (1963)	0526A
Mansfield	Mansfield State College Library (1968)	0515A
Meadville	Allegheny College, Pelletier Library (1907)	0540
Millersville	Millersville State College, Ganser Library (1966)	0521A
Monessen	Monessen Public Library (1969)	0535
New Castle	New Castle Public Library (1963)	0534
Newtown	Bucks County Community College Library (1968)	0518
Norristown	Montgomery County-Norristown Public Library (1969)	0519B
Philadelphia	Drexel University Library (1963)	0511A
	Free Library of Philadelphia (1897)	0515
	Saint Joseph's University, Drexel Library (1974)	0516A
	Temple University, Paley Library (1947)	0516
	Temple University Law Library (1979)	0527A
	Thomas Jefferson University, Scott Memorial Library (1978)	0515B
	U.S. Court of Appeals, Third Circuit Library (1973)	1033
	University of Pennsylvania, Biddle Law Library (1974)	0513C
	University of Pennsylvania Library (1886)	0513B
Pittsburgh	Allegheny County Law Library (1977)	0528
	Carnegie Library of Pittsburgh (1895)	0542
	Carnegie Library of Pittsburgh, Allegheny Regional Branch (1924)	0527

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		Depository No.
	Duquesne University, Law Library (1978)	0528B
	Interior Department, Bureau of the Mines Library (1962)	1001
	La Roche College, John J. Wright Library (1974)	0509A
	University of Pittsburgh, Hillman Library (1910)	0511
	University of Pittsburgh Law Library (1979)	0524A
Pottsville	Pottsville Free Public Library (1967)	0525A
Reading	Reading Public Library (1901)	0525
Scranton	Scranton Public Library (1895)	0522
Shippensburg	Shippensburg State College, Ezra Lehman Memorial Library (1973)	0523A
Slippery Rock	Slippery Rock State College, Bailey Library (1965)	0534A
Swarthmore	Swarthmore College Library (1923)	0510
University Park	Pennsylvania State University Library (1907)	0509
Villanova	Villanova University Law School, Pulling Law Library (1964)	0524
Warren	Warren Public Library (1885)	0531A
Washington	Washington and Jefferson College, U. Grant Miller Library (1884)	0536
Waynesburg	Waynesburg College Library (1964)	0536A
West Chester	West Chester State College, Francis Harvey Green Library (1967)	0521C
Wilkes-Barre	Kings College, D. Leonard Corgan Library (1949)	0522A
Williamsport	Lycoming College Library (1970)	0526
York	York College of Pennsylvania, Schmidt Library (1963)	0530A
Youngwood	Westmoreland County Community College, Learning Resources Center (1972)	0535A

PUERTO RICO

Mayaguez	University of Puerto Rico Library (1928)	0550
Ponce	Catholic University of Puerto Rico, Encarnacion Valdes Library (1966)	0550A
	Catholic University of Puerto Rico, School of Law Library (1978)	0549A
San Juan	University of Puerto Rico, General Library (1928)	0549

RHODE ISLAND

Kingston	University of Rhode Island Library (1907)	0554
Newport	U.S. Naval War College Library (1963)	1010
Providence	Brown University, John D. Rockefeller, Jr. Library (unknown)	0555
	Providence College, Phillips Memorial Library (1969)	0558A
	Providence Public Library (1884)	0556
	Rhode Island College, James P. Adams Library (1965)	0555A
	Rhode Island State Law Library (1979)	0553A
	Rhode Island State Library (before 1895)	0553
Warwick	Warwick Public Library (1966)	0556A
Westerly	Westerly Public Library (1909)	0558
Woonsocket	Woonsocket Harris Public Library (1977)	0557

SOUTH CAROLINA

Charleston	Baptist College at Charleston, L. Mendel Rivers Library (1967)	0564A
	The Citadel, Daniel Library (1962)	0562A
	College of Charleston, Robert Small Library (1869)	0564
Clemson	Clemson University Library (1893)	0560
Columbia	Benedict College, Learning Resources Center (1969)	0565A
	South Carolina State Library (before 1895)	0559
	University of South Carolina, Thomas Cooper Library (1884)	0562
Conway	University of South Carolina, Coastal Carolina College, Kimbel Library (1974)	0569A
Due West	Erskine College, McCain Library (1968)	0566A
Florence	Florence County Library (1967)	0563A
	Francis Marion College, James A. Rogers Library (1970)	0569
Greenville	Furman University Library (1962)	0567
	Greenville County Library (1966)	0567A
Greenwood	Lander College, Larry A. Jackson Library (1967)	0566
Orangeburg	South Carolina State College, Miller F. Whitaker Library (1953)	0561
Rock Hill	Winthrop College, Dacus Library (1896)	0568
Spartanburg	Spartanburg County Public Library (1967)	0563

LIST OF DEPOSITORY LIBRARIES

SOUTH DAKOTA

		Depository No.
Aberdeen	Northern State College Library (1963)	0574B
Brookings	South Dakota State University, H. M. Briggs Library (1889)	0571
Pierre	South Dakota State Library (1973)	0570
	South Dakota Supreme Court Library (1978)	0571A
Rapid City	Rapid City Public Library (1963)	0575A
	South Dakota School of Mines and Technology, Devereaux (1963)	0572A
Sioux Falls	Augustana College, Mikkelsen Library and Learning Resource Center (1969)	0573A
	Sioux Falls Public Library (1903)	0573
Spearfish	Black Hills State College, Library Learning Center (1942)	0575
Vermillion	University of South Dakota, I. D. Weeks Library (1889)	0574A
Yankton	Yankton College, James Lloyd Library (1904)	0572

TENNESSEE

Bristol	Kings College, E. W. King Library (1970)	0576A
Chattanooga	Chattanooga-Hamilton County Bicentennial Library (1908)	0583
	U.S. Tennessee Valley Authority Technical Library (1976)	1039
Clarksville	Austin Peay State University, Woodward Library (1945)	0587
Cleveland	Cleveland State Community College Library (1973)	0583A
Columbia	Columbia State Community College, John W. Finney Memorial Library (1973)	0579A
Cookeville	Tennessee Technological University, Jere Whitson Memorial Library (1969)	0582
Jackson	Lambuth College, Luther L. Gobbel Library (1967)	0584
Jefferson City	Carson-Newman College Library (1964)	0581A
Johnson City	East Tennessee State University, Sherrod Library (1942)	0581
Knoxville	Public Libraries Knoxville-Knox County, Lawson McGhee Library (1973)	0584A
	University of Tennessee at Knoxville, James D. Hoskins Library (1907)	0577
	University of Tennessee Law Library (1971)	0577A
Martin	University of Tennessee at Martin, Paul Meek Library (1957)	0588
Memphis	Memphis-Shelby County Public Library and Information Center (1896)	0590
	Memphis State University, Cecil C. Humphreys School of Law Library (1979)	0582A
	Memphis State University, John W. Brister Library (1966)	0590A
Murfreesboro	Middle Tennessee State University, Todd Library (1912)	0585
Nashville	Fisk University Library (1965)	0586A
	Public Library of Nashville and Davidson County (1884)	0586
	Tennessee State Law Library (1976)	0585A
	Tennessee State Library and Archives (unknown)	0576
	Tennessee State University, Brown-Daniel Library (1972)	0587A
	Vanderbilt University Law Library (1976)	0580A
	Vanderbilt University Library (1884)	0580
Sewanee	University of the South, Jessie Ball duPont Library (1873)	0579

TEXAS

Abilene	Abilene Christian University, Margaret and Herman Brown Library (1978)	0612A
	Hardin-Simmons University, Rupert and Pauline Richardson Library (1940)	0612
Arlington	Arlington Public Library (1970)	0607A
	University of Texas at Arlington Library (1963)	0607B
Austin	Texas State Law Library (1972)	0593A
	Texas State Library (unknown)—REGIONAL	0591
	University of Texas at Austin, Perry Castañeda Library (1884)	0605
	University of Texas, Lyndon B. Johnson School of Public Affairs Library (1966)	0593
	University of Texas, Tarlton Law Library (1965)	0605A
Baytown	Lee College Library (1970)	0592A
Beaumont	Lamar University, Mary and John Gray Library (1957)	0597
Brownwood	Howard Payne University, Walker Memorial Library (1964)	0616
Canyon	West Texas State University, Cornette Library (1928)	0613
College Station	Texas Agricultural and Mechanical University Library (1907)	0592
Commerce	East Texas State University Library (1937)	0599
Corpus Christi	Corpus Christi State University Library (1976)	0591D
Corsicana	Navarro College, Gaston T. Gooch Library (1965)	0601
Dallas	Bishop College, Zale Library (1966)	0600A
	Dallas Baptist College, Vance Memorial Library (1967)	0594A

		Depository No.
	Dallas Public Library (1900)	0594
	Southern Methodist University, Fondren Library (1925)	0600
	University of Texas, Health Science Center-Dallas Library (1975)	0589
Denton	North Texas State University Library (1948)	0608A
Edinburg	Pan American University Library (1959)	0610
El Paso	El Paso Public Library (1906)	0611
	University of Texas at El Paso, Documents and Maps Library (1966)	0611A
Fort Worth	Fort Worth Public Library (1905)	0607
	Texas Christian University, Mary Couts Burnett Library (1916)	0607A
Galveston	Rosenberg Library (1909)	0604
Houston	Houston Public Library (1884)	0603
	North Harris County College, Learning Resource Center (1974)	0592B
	Rice University, Fondren Library (1967)	0608C
	South Texas College of Law Library (1981)	0609A
	University of Houston at Clear Lake City Library (1980)	0603A
	University of Houston School of Law Library (1979)	0597B
	University of Houston Library (1957)	0608
Huntsville	Sam Houston State University Library (1949)	0602
Irving	Irving Public Library (1974)	0594C
Kingsville	Texas Arts and Industries University, Jernigan Library (1944)	0609
Laredo	Laredo Junior College, Harold R. Yeary Library (1970)	95A
Longview	Nicholson Memorial Public Library (1961)	0598
Lubbock	Texas Tech University Law Library (1978)	0597A
	Texas Tech University Library (1935)—REGIONAL	0614
Marshall	Wiley College, Cole Library (1962)	0596
Nacogdoches	Stephen F. Austin State University, Steen Library (1965)	0602A
Plainview	Wayland Baptist University, Van Howeling Memorial Library (1963)	0614A
Richardson	University of Texas at Dallas Library (1972)	0594B
San Angelo	Angelo State University, Porter Henderson Library (1964)	0616A
San Antonio	Saint Mary's University, Academic Library (1964)	0615A
	San Antonio College Library (1972)	0591B
	San Antonio Public Library (1899)	0615
	Trinity University Library (1964)	0615B
	University of Texas at San Antonio Library (1973)	0616B
San Marcos	Southwest Texas State University Library (1955)	0595
Seguin	Texas Lutheran College, Blumberg Memorial Library (1970)	0595B
Sherman	Austin College, Arthur Hopkins Library (1963)	0599A
Texarkana	Texarkana Community College, Palmer Memorial Library (1963)	0596A
Victoria	Victoria College/University of Houston, Victoria Campus Library (1973)	0591C
Waco	Baylor University Library (1905)	0606
Wichita Falls	Midwestern University, Moffett Library (1963)	0608B

UTAH

Cedar City	Southern Utah State College Library (1964)	0620A
Ephraim	Snow College, Lucy A. Phillips Library (1963)	0621
Logan	Utah State University, Merrill Library and Learning Resources Center (1907)— REGIONAL	0618
Ogden	Weber State College, Stewart Library (1962)	0620
Provo	Brigham Young University, J. Reuben Clark Law Library (1972)	0621A
	Brigham Young University, Lee Library (1908)	0619
Salt Lake City	University of Utah, Marriott Library (1893)	0622
	University of Utah, Eccles Health Sciences Library (1970)	0619A
	University of Utah Law Library (1966)	0622A
	Utah State Library (unknown)	0617
	Utah State Supreme Court, Law Library (1975)	0617A

VERMONT

Burlington	University of Vermont, Bailey Library (1907)	0624
Castleton	Castleton State College, Calvin Coolidge Library (1969)	0626A
Johnson	Johnson State College, John Dewey Library (1955)	0625

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LIST OF DEPOSITORY LIBRARIES

		Depository No.
Lyndonville	Lyndon State College, Samuel Reed Hall Library (1969)	0625A
Middlebury	Middlebury College, Egbert Starr Library (1884)	0627
Montpelier	Vermont Department of Libraries (before 1895)	0623
Northfield	Norwich University Library (1908)	0627A
South Royalton	Vermont Law School Library (1978)	0623A

VIRGIN ISLANDS

Saint Croix	Florence Williams Public Library (1974)	0627D
Saint Thomas	College of the Virgin Islands, Ralph M. Paiewonsky Library (1973)	0627C
	Enid M. Baa Public Library and Archives (1968)	0627B

VIRGINIA

Alexandria	Navy Department, Judge Advocate General Law Library (1963)	1009
Arlington	George Mason University, School of Law Library (1981)	0640A
Blacksburg	Virginia Polytechnic Institute and State University, Carol M. Newman Library (1907)	0629
Bridgewater	Bridgewater College, Alexander Mack Memorial Library (1902)	0639
Charlottesville	University of Virginia, Alderman Library (1910)—REGIONAL	0640
	University of Virginia, Arthur J. Morris Law Library (1964)	0632A
Chesapeake	Chesapeake Public Library System (1970)	0636A
Danville	Danville Community College, Learning Resources Center (1969)	0637
Emory	Emory and Henry College, Kelly Library (1884)	0641
Fairfax	George Mason University, Fenwick Library (1960)	0641A
Fredericksburg	Mary Washington College, E. Lee Trinkle Library (1940)	0633
Hampden-Sidney	Hampden-Sidney College, Eggleston Library (1891)	0636
Hampton	Hampton Institute, Huntington Memorial Library (1977)	0631A
Harrisonburg	James Madison University, Madison Memorial Library (1973)	0628E
Hollins College	Hollins College, Fishburn Library (1967)	0628A
Lexington	Virginia Military Institute, Preston Library (1874)	0639A
	Washington and Lee University, University Library (1910)	0632
	Washington and Lee University, Wilbur C. Hall Law Library (1978)	0630B
Martinsville	Patrick Henry Community College Library (1971)	0637A
Norfolk	Norfolk Public Library (1895)	0634
	Old Dominion University Library (1963)	0634A
	U.S. Armed Forces Staff College Library (1963)	1012
Petersburg	Virginia State University, Johnston Memorial Library (1907)	0630
Quantico	Federal Bureau of Investigation, Academy Library (1970)	1025
	U.S. Marine Corps Schools, James Carson Breckinridge Library (1967)	1018
Reston	Department of the Interior, Geological Survey National Center Library (1962)	1008
Richmond	U.S. Court of Appeals, Fourth Circuit Library (1973)	1032
	University of Richmond, Boatwright Memorial Library (1900)	0635
	University of Richmond, Law School Library (1982)	0635B
	Virginia Commonwealth University, James Branch Cabell Library (1971)	0635A
	Virginia State Law Library (1973)	0630A
	Virginia State Library (unknown)	0628
Roanoke	Roanoke Public Library (1964)	0638A
Salem	Roanoke College Library (1886)	0638
Williamsburg	College of William and Mary, Marshall Wythe Law Library (1978)	0633A
	College of William and Mary, Swem Library (1936)	0631
Wise	Clinch Valley College, John Cook Wyllie Library (1971)	0629A

WASHINGTON

Bellingham	Western Washington University, Wilson Library (1963)	0647A
Cheney	Eastern Washington University, JFK Library (1966)	0650A
Ellensburg	Central Washington University Library (1962)	0649A
Everett	Everett Public Library (1914)	0647
Olympia	Evergreen State College, Daniel J. Evans Library (1972)	0648A
	Washington State Law Library (1979)	0644A
	Washington State Library (unknown)—REGIONAL	0642

LIST OF DEPOSITORY LIBRARIES

		Depository No.
Port Angeles	North Olympic Library System, Port Angeles Branch (1965)	0647B
Pullman	Washington State University Library (1907)	0643
Seattle	Seattle Public Library (1908)	0646
	University of Washington, Marian Gould Gallagher Law Library (1969)	0645A
	University of Washington Library (1890)	0644
	U.S. Court of Appeals, Ninth Circuit Library (1981)	1053
Spokane	Gonzaga University, School of Law Library (1979)	0646A
	Spokane Public Library (1910)	0650
Tacoma	Tacoma Public Library (1894)	0651
	University of Puget Sound, Collins Memorial Library (1938)	0645
	University of Puget Sound, Law Library (1978)	0643A
Vancouver	Fort Vancouver Regional Library (1962)	0648
Walla Walla	Whitman College, Penrose Memorial Library (1890)	0649

WEST VIRGINIA

Athens	Concord College Library (1924)	0656
Bluefield	Bluefield State College, Hardway Library (1972)	0653A
Charleston	Kanawha County Public Library (1952)	0655
	West Virginia Library Commission (unknown)	0652
	West Virginia Supreme Court Law Library (1977)	0652A
Elkins	Davis and Elkins College Library (1913)	0658
Fairmont	Fairmont State College Library (1884)	0657
Glenville	Glenville State College, Robert F. Kidd Library (1966)	0656A
Huntington	Marshall University, James E. Morrow Library (1925)	0660
Institute	West Virginia College of Graduate Studies Library (1977)	0657A
	West Virginia State College, Drain-Jordan Library (1907)	0654
Morgantown	West Virginia University Library (1907)—REGIONAL	0653
Salem	Salem College Library (1921)	0659
Shepherdstown	Shepherdstown College, Ruth Scarborough Library (1971)	0658A
Weirton	Mary H. Weir Public Library (1963)	0655A

WISCONSIN

Appleton	Lawrence University, Seeley G. Mudd Library (1869)	0674
Beloit	Beloit College, Col. Robert H. Morse Library (1888)	0666
Eau Claire	University of Wisconsin-Eau Claire, William D. McIntyre Library (1951)	0675
Fond Du Lac	Fond Du Lac Public Library (1966)	0672A
Green Bay	University of Wisconsin-Green Bay, Library Learning Center (1968)	0674A
La Crosse	La Crosse Public Library (1883)	0669
	University of Wisconsin-La Crosse, Murphy Library (1965)	0666A
Madison	Madison Public Library (1965)	0668A
	State Historical Society Library (1870)—REGIONAL	0668
	University of Wisconsin-Madison Memorial Library (1939)	0664
	University of Wisconsin-Madison, Law Library (1981)	0663A
	Wisconsin State Law Library (unknown)	0663
Milwaukee	Alverno College Library/Media Center (1971)	0661A
	Medical College of Wisconsin, Inc., Todd Wehr Library (1980)	0661B
	Milwaukee County Law Library (1934)	0671
	Milwaukee Public Library (1861)—REGIONAL	0670
	Mount Mary College Library (1964)	0671B
	University of Wisconsin-Milwaukee Library (1960)	0671A
Oshkosh	University of Wisconsin-Oshkosh, Forrest R. Polk Library (1956)	0672
Platteville	University of Wisconsin-Platteville, Karrmann Library (1964)	0669A
Racine	Racine Public Library (1898)	0667
Ripon	Ripon College Library (1982)	0665B
River Falls	University of Wisconsin-River Falls, Chalmer Davee Library (1962)	0675A
Stevens Point	University of Wisconsin-Stevens Point, Learning Resources Center (1951)	0673
Superior	Superior Public Library (1908)	0676
	University of Wisconsin-Superior, Jim Dan Hill Library (1935)	0665
Waukesha	Waukesha Public Library (1966)	0670A
Wausau	Marathon County Public Library (1971)	0673A
Whitewater	University of Wisconsin-Whitewater, Harold Anderson Library (1963)	0667A

LIST OF DEPOSITORY LIBRARIES

WYOMING

		Depository No.
Casper	Natrona County Public Library (1929)	0680
Cheyenne	Wyoming State Law Library (1977)	0678A
	Wyoming State Library (unknown)—REGIONAL	0677
Gillette	George Amos Memorial Library (1980)	0679B
Laramie	University of Wyoming, Coe Library (1907)	0678
	University of Wyoming Law Library (1978)	0679A
Powell	Northwest Community College Library (1967)	0681A
Riverton	Central Wyoming College Library (1969)	0679
Rock Springs	Western Wyoming College Library (1969)	0680A
Sheridan	Sheridan College Library (1963)	0681

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SB-176
August 12, 1983

PUBLICATIONS RELATING TO THE 1983-84
COLLEGE DEBATE TOPIC

Resolved, That Any and all Injury Resulting From the Disposal of Hazardous Wastes in the United States Should be the Legal Responsibility of the Producer of That Waste.

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___Acid Rain: Research Summary. 1979. 23 p. il.
EP 1.2:Ac 4 S/N 055-000-00185-5 $ 3.25

___Closure of Hazardous Waste Surface Impoundments. *Presents a listing of closure plan and post-closure care considerations and details for surface impoundments (SI's) containing hazardous wastes. It describes the methods, tests, and procedures involved in closing a site to: minimize further maintenance, protect human health and the environment, avoid escape of hazardous wastes, control leachate, and avoid contaminated rainfall, ground water, surface water, or atmosphere.* Rev. 1982. 100 p. il.
EP 1.17:873 S/N 055-000-00227-4 5.50

___Contamination of Ground Water by Toxic Organic Chemicals.
1981. 98 p. PrEx 14.2:C 76/2 S/N 041-011-00064-5 5.50

___Draft Manual for Infectious Waste Management. 1982.
147 p. EP 1.17:957 S/N 055-000-00223-1 6.00

___Environmental Health: A Study of the Issues in Locating, Assessing, and Treating Individuals Exposed to Hazardous Substances. 1980. 54 p. il.
HE 20.6202:En 8/2 S/N 017-022-00725-8 4.75

___Federal Role in the Federal System: The Dynamics of Growth, Protecting the Environment: Politics, Pollution, and Federal Policy. *Reviews the origins and growth of the Federal role in environmental protection.* 1981. 70 p. il.
Y 3.Ad 9/8:2 En 8/2 S/N 052-004-00086-1 5.00

___Guide to the Disposal of Chemically Stabilized and Solidified Waste. *Examines procedures for treatment of hazardous industrial wastes for disposal, including physical and chemical test procedures, and outlines options for ultimate disposal of treated wastes.* Rev. 1982. 125 p. il.
EP 1.17:872 S/N 055-000-00226-6 6.00

___Hazardous Wastes. 1976. 24 p. il.
EP 1.17:138 S/N 055-002-00137-8 3.25

___Hazardous Waste Disposal. *Report together with additional and separate views.* 1979. 82 p.
Y 4.In 8/4:H 33/2 S/N 052-070-05137-0 $ 4.50

___ Waste Disposal Site Survey, Report to the above. *Report together with additional and separate views. This survey was conducted in conjunction with the subcommittee's investigation of disposal problems, the results of which are contained in the report.* 1979. 487 p.
Y 4.In 8/4:W 28 S/N 052-070-05148-5 8.50

___Hazardous Waste Sites and Hazarddus Substance Emergencies. *Provides information useful to workers involved in hazardous waste emergencies.* 1983. 25 p. il.
HE 20.7117/2:H 33 S/N 017-033-00401-3 3.75

___Landfill and Surface Impoundment Performance Evaluation Manual. Rev. 1983. 81 p. il.
EP 1.17:869/2 S/N 055-000-00233-9 5.00

Love Canal:

___ Environmental Monitoring at Love Canal, Volume 1. *Describes the results of a comprehensive multimedia environmental monitoring study conducted by the United States Environmental Protection Agency in Love Canal, in Niagara Falls, New York. Contains an overview of the monitoring program; background information on the site and history; design of the monitoring studies, results of the investigations, summary and conclusions.* 1982. 315 p. il. EP 1.23/5:600/4-82-030 A
S/N 055-000-00220-7 8.50

___ Habitability of the Love Canal Area, A Technical Memorandum. *Includes OTA's findings in the habitability decision, and the four arguments on which they are based; outlines the possible steps toward rehabitation; and describes the implications for the Federal Superfund program.* 1983. 66 p. il. Y 3.T 22/2:11 L 94 S/N 052-003-00917-0 4.00

___Nonnuclear Industrial Hazardous Waste, Classifying for Hazard Management, A Technical Memorandum. 1981. 44 p. il.
Y 3.T 22/2:11 W 26 S/N 052-003-00859-9 3.00

___Nuclear Regulatory Legislation Through the Ninety-Seventh Congress, Second Session. 1983. 287 p.
Y 4.In 8/14:N 88/5/983
S/N 052-070-05830-7 6.50

___Nuclear Waste Policy Act of 1982, Public Law 97-425. An Act to Provide for the Development of Repositories for the Disposal of High-Level Radioactive Waste and Spent Nuclear Fuel, to Establish a Program of Research, Development, and Demonstration Regarding the Disposal of High-Level Radioactive Waste and Spent Nuclear Fuel, and for Other Purposes. Approved January 7, 1983. 63 p.
GS 4.110:97/425 S/N 022-003-95707-3 4.50

___Occupational Health Guidelines for Chemical Hazards. *Summarizes information on permissible exposure limits, chemical and physical properties, and health hazards. Provides recommendations for medical surveillance, respiratory protection, and personal protection and sanitation practices for specific chemicals that have Federal occupational safety and health regulations.* 1981. 1630 p. il. 3 books, sold as a set. Issued in looseleaf form.
HE 20.7108:C 42/3 S/N 017-033-00337-8 $34.00

___Publications on Toxic Substances, A Descriptive Listing. *Presents some basic facts about toxic substances and lists and describes some publications that are available from the Consumer Product Safety Commission, Environmental Protection Agency, Food and Drug Administration, and Occupational Safety and Health Administration.* 1979. 96 p.
Y 3.R 26/2:2 T 66 S/N 052-011-00226-7 4.50

___Registry of Toxic Effects of Chemical Substances. (Quarterly, January, April, July, and October.) Subscription price: Domestic - $41.00 a year: Foreign - $51.25 a year. Single copy price: Domestic - $12.00 a copy; Foreign - $15.00 a copy. ISSUED IN MICROFICHE ONLY (48X) [RTECS] (File Code 2Q)
HE 20.7112/3: S/N 017-033-80001-4

___Registry of Toxic Effects of Chemical Substances, 1980, Volumes 1-2. *Provides basic information on the known toxic and biological effects of chemical substances for the use of employers, employees, physicians, industrial hygienists, toxicologists, researchers, and others.* 1982. 2056 p. 2 volumes, sold as a set.
HE 20.7112:980/v.1-2 S/N 017-033-00399-8 27.00

___Residential Waste Collection: Hazard Recognition and Prevention. *Intended to assist residential waste collection employers, collectors, and worker representatives in identifying, evaluating and eliminating the major hazards of refuse collection.* 1982. 84 p. il.
HE 20.7102:W 28 S/N 017-033-00400-5 6.00

___Selection of Hazardous Waste Sites for Superfund Funding, Workshop, March 19-20, 1982. 1982. 110 p. il.
Y 4.Ap 6/2:W 28/2 S/N 052-070-05775-1 5.00

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